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Seismic Hazards In Unreinforced Masonry Buildings In The Pacific Northwest

FINDINGS ON THE STRUCTURAL CONDITIONS OF UNREINFORCED MASONRY BUILDINGS IN SEVEN STUDY TOWNS

Fractured Facade Element

Prepared for
National Science Foundation
Earthquake Hazards Mitigation Program

SEISMIC HAZARDS IN UNREINFORCED MASONRY BUILDINGS IN SMALL TOWNS IN THE PACIFIC NORTHWEST

Findings on the Structural Conditions of Unreinforced Masonry Buildings in Seven Study Towns

A Collaborative Effort Between the University of Washington
Department of Civil Engineering, Chairman Neil Hawkins,
And
The Northwest Institute for Historic Preservation
Padraic Burke, Chairman

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The research team would like to thank all the building owners, town officials and interested individuals who assisted us in the completion of this study. It would not have been possible to conduct the research without the cooperation of the building owners who gave us permission to survey the structural conditions of their buildings. Though we can not salute all thirty five owners individually we do hope that their participation will, with the continued research that will follow this study, help them in the difficult task of preserving older and historic buildings in small towns.

Seismic Hazards and Provisions in Older and Historic Unreinforced Masonry Buildings in Small Towns

Executive Summary

This Report presents the findings of a research investigation conducted in seven small towns in the Pacific Northwest and concerned with the potential seismic hazards of older unreinforced masonry buildings in those towns. In such towns a high percentage of the older unreinforced masonry buildings, often historic, contain significant seismic hazards of which the communities, building owners, and often the building officials are not aware. Due to a variety of factors, which are clarified in this study, those potential hazards have been allowed to continue to exist and because of neglect, to worsen. In many instances those hazards endanger the life and limb of the residents of those communities as well as the economic livelihood of the community itself.

The Northwest is one of several active seismic regions in the country. Earthquakes will occur in the Pacific Northwest again as they have in the past. Though buildings have survived several past earthquakes, the research team found that the effects of deterioration and lack of maintenance had become pronounced, and those structures were not likely to survive a significant future seismic event.

A significant factor contributing to the continued existence of these potential hazards was the lack of knowledge within the community concerning the structural characteristics of masonry buildings, and the belief that brick buildings were inherently strong. As a result of this lack of knowledge among building owners and town officials, potential hazards have become an accepted element of the town landscape, unrecognized as a threat, and unmitigated as a hazard.

It has been demonstrated in past earthquakes that Unreinforced masonry buildings are one of the more dangerous types of buildings in terms of partial or total collapse during a seismic event. The unreinforced masonry building by definition is not designed to withstand the lateral forces generated by an earthquake. The findings in the town revealed the extent of the seismic hazards that existed, but even more alarming was the level of deterioration that was found to be pervasive in the study town buildings. This deterioration affects not only potential seismic hazards but reduces the ability of the structure to withstand even gravity loads. This deterioration could endanger the long term survivability of these important town buildings.

The study and its findings should help educate small town building owners and local officials to the potential seismic hazards posed by older unreinforced masonry buildings. Although only seven towns were studied many Pre-1900 unreinforced masonry structures exist in other communities in Washington, Oregon and Idaho and are likely to contain similar potential hazards.
A better understanding of the need to maintain the structural integrity of older, and historic, masonry buildings at the community level in the Northwest would be instrumental in insuring the longevity of these important economic and cultural resources while at the same time reducing the hazards posed by those buildings.

I. Introduction

The following report summarizes the findings of a year long study concerning the seismic hazards and code provisions in older and historic unreinforced masonry buildings in small towns in the Pacific Northwest. The initial findings were presented at a conference in Seattle, Washington on November 8 and 9th, 1984. The material that follows is based on the survey that took place between May 1, 1984 and November 1, 1984.

The research was funded by the National Science Foundation and conducted by the University of Washington's Department of Civil Engineering and the Northwest Institute For Historic Preservation.

Neil M. Hawkins, Chairman of the Department of Civil Engineering was the principal investigator and research coordinator. Padraic Burke, Chairman Northwest Institute for Historic Preservation managed the subcontract to all consultants and coordinated the research objectives in the study towns.

The following individuals were members of the research team and made possible the achievement of research objectives.

Robert Brenlin (Field Coordinator, Vice-Chairman Northwest Institute for Historic Preservation)

Barry Onouye (Professional Engineer, Lecturer, Department of Architecture, University of Washington)

Christopher Peragine (Graduate Student,Department of Archtecture, University of Washington

Andris Vanags (Materials Specialist,Lecturer, Department of Architecture, University of Washington)

Other individuals whose help was essential in the completion of this document include Dave Goldsmith, Planning Director of Jefferson County who assisted with advice and critique and Patrick McGreevy, land use attorney, who researched related legal issues.

The methodology for the survey of the potential seismic hazards in small town unreinforced masonry buildings was adapted by Barry Onouye and Andris Vanags from previous National Science Foundation reports and is described more fully in section B .

The study document was written by Padraic Burke and Robert Brenlin and edited by the research team with graphic coordination by Christopher Peragine.

A. Purpose of the Study

The purpose of the study was to investigate the condition of older and historic unreinforced masonry buildings (URM) in small towns in the Pacific Northwest to determine the potential hazards these buildings could pose during an earthquake, to identify how seismic provisions were being applied as a component of local building codes,and the manner in which seismic considerations have been taken into account in the maintenance and rehabilitation of these buildings in the study towns.

The Study Objectives: The specific research objectives were as follows:

--Determine the process by which small town officials review the rehabilitation of unreinforced masonry buildings for seismic requirements.

--Identify the economic considerations that affect the application of seismic provisions.

--Investigate the structural condition of case study buildings in seven small towns and the potential hazards they may pose during a seismic event.

--Develop a checklist, survey form, and methodology for the visual inspection of small town buildings.

--Develop a model that would clarify the factors that influence the application of codes in small communities.

--Identify the legal, economic, and possible life safety consequences that could arise if seismic provisions were not applied as part of the local building codes.

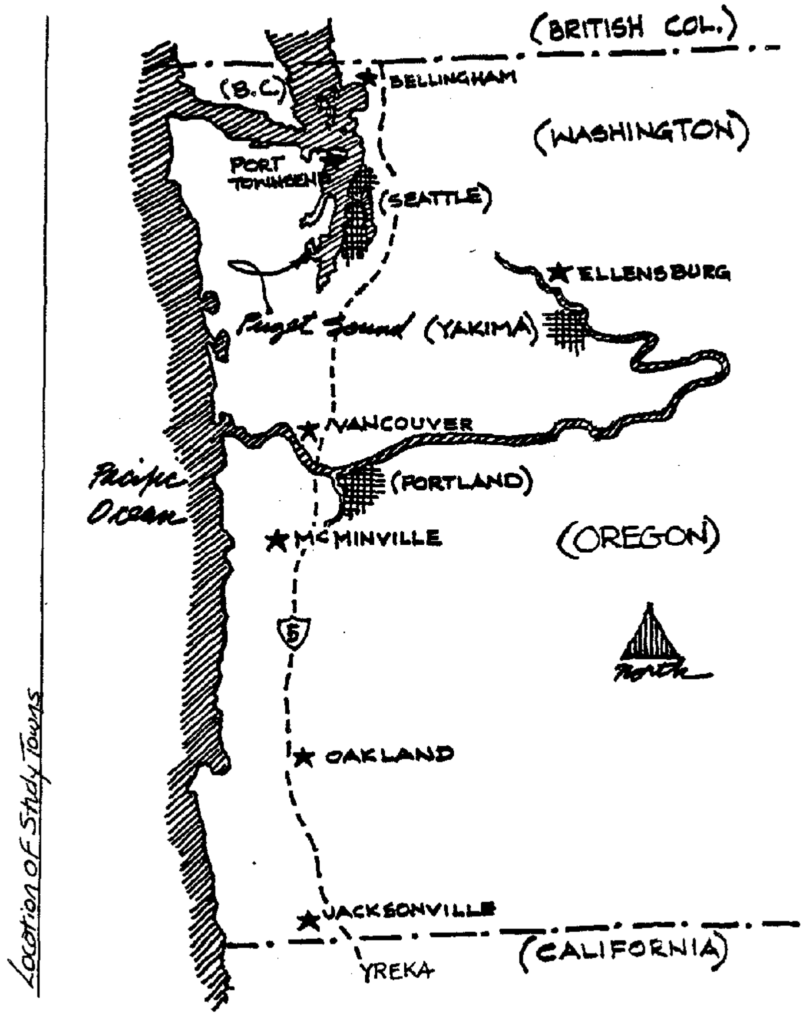
B. **Selection of survey towns and methodology for identification of potential hazards.**

The initial approach was to examine URM structures in the context of the small towns in the Pacific Northwest (Oregon and Washington). Small towns are of particular interest because they often do not have the technical expertise relevant to sesimic hazards mitigation or adequate financial resources within the community that can be applied in the process of rehabilitation or maintenance of URM structures.

1) Selection of the Survey Towns

Towns were selected that varied in population and had representative stock of unreinforced masonry buildings. Four towns were examined in Washington and three in Oregon. The populations of these towns varied in size from a high of 50,000 in Vancouver and Bellingham to a low of 890 in Oakland, Oregon.

The other towns studied included Port Townsend, Washington, at 5,100; Ellensburg, Washington, at 11,000; McMinnville, Oregon, at 13,000; and Jacksonville, Oregon, at 1,200. The towns selected ranged geographically over a distance of approximately 600 miles from northern Washington to Southern Oregon.The economic base of these towns varied considerably from the tourism dominated Port Townsend to the primarily industrial and port based economies of Bellingham and Vancouver, Washington.



Although only 35 buildings were surveyed for potential hazards the entire stock of URM buildings in the seven towns was given limited review. The configuration, height, ownership, and use of the buildings in the sample survey varied widely and a large number of the buildings were either in historic districts or worthy of being classed as "historic". The downtown business districts of Jacksonville and Oakland Oregon, and Port Townsend Washington were all classified as "historic districts" listed on the National Register of Historic Places. The listing of the building on the National Register represents more than simply prestige; it identifies a cultural resource of significant importance for both the community and the state.

Five case study buildings were selected in each town for closer examination. The owner of each building in each town was contacted in order to piece together the history and process of the rehabilitation that took place. With the owner's authorization a survey was then conducted of the building to identify its structural condition and the potential hazards that existed. As a result of these two steps, the discussion with the owner of the rehabilitation history, and the survey of potential hazards we could identify the factors that affect the condition of URM structures.

2) Methodology for Surveying the Potential Seismic Hazards of URM Buildings in Small Towns in Oregon and Washington

The methodology created for the survey of older unreinforced masonry buildings reported in this study was based primarily on the work conducted by ABK Associates, a joint venture of three firms: Agbabian Associates; S. B. Barnes & Associates; and J. C. Kariotis; and funded by the National Science Foundation. The methodology was published by ABK as Topical Report 08: "Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings".

While this small town study followed the recommendations of the ABK report, many buildings in several location in the Pacific Northwest were examined in order to discern how conditions varied between locations, in what ways they varied, and whether similar problems existed for URM buildings within the Pacific Northwest similar to the problems identified by ABK for URM buildings in the Los Angeles area.

Because of the age of the buildings examined in most cases drawings or documents describing their architectural and structural systems were not available. Further, the time available for the field survey precluded the research team from being able to create drawings of the buildings, or being able to remove finishes to access the actual structure.

A field survey form or "checklist" was created on the basis of the elements identified in ABK's NSF methodology. A survey checklist follows.

FIELD SURVEY FOR SEISMIC RESISTANCE EVALUATION
NSF SMALL TOWNS- SEISMIC GRANT

I. ARE THERE ANY BEAMS, TRUSSES OR MAJOR LINTELS THAT BEAR ON URM PIERS, PILASTERS OR WALLS?

A. FOUNDATION/ BASEMENT/ CRAWL SPACE
BRICK FOUNDATION BEARS CENTRAL FLOOR BEAM- JOISTS POCKET INTO MASONRY WITH ANGLE IRON UNDERNEATH

B. FIRST STORY
STORE-FRONT WINDOW OPENINGS AND ENTRIES: RENOVATED SINCE ORIGINAL BUILDING CONSTRUCTED

C. SECOND, THIRD, FOURTH, ETC...
NONE

D. ROOF
NO

E. OTHER
NO

II. ARE THERE ANY LOAD CARRYING SYSTEMS THAT MAY ACT AS TIES TO VERTICAL LATERAL LOAD RESISTING ELEMENTS?

A. ON EXTERIOR OF BUILDING
NO

B.IN INTERIOR OF BUILDING
NO

C. OTHER LOCATIONS
NO

III. ARE THERE ANY URM WALLS THAT ARE DISCONTINUOUS TO THE BASE OF THE BUILDING?

A. NORTH ELEVATION
NO

B. SOUTH ELEVATION
YES- ENTRANCE

C. EAST ELEVATION
NO

D. WEST ELEVATION
YES- OPEN STORE FRONT

E. INTERNAL
NO

IV. ARE THERE ANY WALLS THAT ARE CONTINUOUS BETWEEN ROOFS OR FLOORS AND ROOF? (NOT NECESSARILY LOAD BEARING)

A. BASEMENT TO FIRST STORY
NONE OBSERVED

B. FIRST STORY TO SECOND
SOME CROSSWALLS IN BACK SECTION AND BETWEEN SHOPS

C. SECOND TO THIRD, ETC.
WALL PARTITIONS AT SECOND AND THIRD FLOORS- FOURTH FLOOR UNFINISHED- NO PARTITION WALL SHEATHING

D. TO ROOF
NONE

E. OTHER (MEZZANINE, ETC.)
NONE

V. ARE THE ROOF AND CEILING FRAMING...

A. THE SAME
NO

B. SEPARATED
YES- CEILING JOISTS (AT THIRD AND FOURTH LEVELS) EMBEDDED IN URM WALL- ROOF RAFTERS REST ON CRIPPLE FRAMING EXTENDING FROM FOURTH LEVEL CEILING JOISTS

C. CEILING TIED / ROOF UNTIED
YES- THIRD AND FOURTH LEVEL CEILINGS ARE TIED INTO URM WALL- ROOF IS UNTIED

D. CEILING AND ROOF TIED
NO

E. OTHER
NO

VI. ARE THERE ANY "UNDESIGNED" TRUSSES THAT MAY GIVE STIFFNESS TO THE ROOF ASSEMBLY IN A PARTICULAR DIRECTION?

A. NORTH- SOUTH
NO

B. EAST-WEST
NO

VII. IS THERE CONTINUITY OF FLOORING MATERIAL OVER THE ENTIRE FLOOR?

A. FIRST FLOOR
YES- STRAIGHT SHIPLAP WITH WOOD STRIP OVER

B. SECOND FLOOR
SAME AS FIRST

C. THIRD FLOOR
SAME AS PREVIOUS FLOORS

D. OTHER FLOORS
FOURTH FLOOR- YES

VIII. ARE THERE ANY OPENINGS THROUGH FLOORS ADJACENT TO A URM WALL?
NO

IX. WHAT ARE THE ROOF SHEATHING AND ROOFING MATERIALS?
SHIPLAP LAID PERPENDICULAR TO ROOF JOISTS WITH HOT MOP ROOFING APPLIED ON TOP

X. ARE THERE DISCONTINUITIES IN ROOF SHEATHING OR ROOFING MATERIALS ADJACENT TO URM WALLS?
NO

XI. IS THERE ANCHORAGE OF URM WALLS TO FLOORS AND ROOFS?
YES- METAL ROD ANCHORS FOUND AT THIRD, FOURTH AND ROOF LEVELS. APPROXIMATE SPACING IS FOUR FEET ON CENTER

XII. ARE THERE ANY PARAPETS/CORNICES ABOVE EXISTING ANCHORAGE LEVELS? (GIVE APPROX. HEIGHT)
YES- 10 FEET AT FRONT AND BACK; 4 FEET AT WEST SIDE; 8 FEET AT EAST SIDE; PARAPETS TIED TO CEILING JOISTS AT FOUR FEET ON CENTER; URM CORNICE WORK ON SOUTH AND WEST ELEVATIONS

XIII. ARE THERE ANY TERRA COTTA, CAST STONE OR STONE FACINGS SECURELY ANCHORED?
YES- MASONARY CORBELING AT PARAPETS AROUND SOUTH AND WEST SIDES

XIV. ARE THERE ANY AREAS OF ERODED MORTAR?
YES- SIGNIFICANT WATER DAMAGE TO MORTAR AT ALL LEVELS. SINCE THEN, SOUTH AND EAST WALLS HAVE BEEN REPOINTED

XV. ARE THERE ANY AREAS OF DETERIORATED BRICK OR STONE?
NONE OBSERVED

XVI. ARE THERE ANY CRACKS VISIBLE IN URM WALLS AND WHAT MAY HAVE BEEN THE CAUSE?
NONE OBSERVED

COMMENTS:
COLUMNS NOT TIED TO BEAMS AT BASEMENT- MAIN BEAM DAMAGE DUE TO PENETRATION OF PLUMBING LINE ON TENSION FACE. CRUSHING OF TIMBER PLATES EVIDENT THROUGHOUT BASEMENT LEVEL. PROBABLE CAUSE IS THE TWO STORIES ADDED IN 1920S OR 30S WITHOUT CHANGE OF LOWER STRUCTURAL SUPPORT SYSTEM

IDENTIFICATION OF HAZARDOUS BUILDING ELEMENTS

BUILDING:

EPA (EFFECTIVE PEAK ACCELERATION) ZONE- .05 g. ATC ZONE 2

DESCRIPTION OF BUILDING

DATE OF CONSTRUCTION:
DATE OF ADDITION(S):
DATE OF RENOVATION(S)

GENERAL DESCRIPTION:
FOUR STORY MASONRY BUILDING BUILT STORE FRONTS ON MAIN FLOOR. TWO STORIES ADDED IN 1920'S WITH UPPER STORY INTERIOR NEVER COMPLETED. STORE FRONTS STILL IN USE, UPPER THREE STORIES UNOCCUPIED.

IDENTIFICATION OF POTENTIALLY HAZARDOUS BUILDING ELEMENTS

I- EFFECTIVE PEAK ACCELERATION- 0.1 G.

A. EXTENSIONS OR ATTACHMENTS ABOVE UPPERMOST (OR POTENTIAL) ANCHORAGE LEVEL

1. CORNICES (URM)
YES- ON SOUTH AND WEST ELEVATIONS

2. PARAPETS (URM)
YES- TEN FOOT PARAPETS ON NORTH AND SOUTH ELEVATIONS; FOUR FOOT PARAPET ON WEST WALL; EIGHT FOOT PARAPET ON EAST WALL; HOWEVER TIED TO CEILING JOISTS AT FOUR FEET ON CENTER

3. OTHERS
YES- MASONRY CORBELING AT PARAPETS AROUND SOUTH AND WEST WALLS

B. URM WALLS ADJACENT TO ROOF ELEMENTS NOT CONTINUOUS WITH MAJOR PLANE OF ROOF SHEATHING

1. MANSARD ROOFS
NONE

2. ROOF EDGES PITCHED FOR DRAINAGE
NOT OBSERVED

3. NORTH SKYLIT ROOFS
NONE

4. OTHERS
NONE

C. URM WALLS ADJACENT TO SKYLIGHTS AND/OR OTHER OPENINGS THROUGH ROOF(S) AND/OR FLOOR(S)

NONE AT ROOF OR FLOOR LEVELS

D. URM WALLS WITH UNBONDED VENEER COURSES
NONE

E. URM WALLS WITHOUT ANCHORS TO ROOF(S) AND FLOOR(S) ABOVE GROUND
NO EVIDENCE OF FLOOR TIES TO URM WALLS AT FIRST AND SECOND FLOORS, BUT METAL ROD ANCHORS FOUND AT THIRD, FOURTH AND ROOF DIAPHRAGM LEVELS

F. GABLE ENDS OF URM WALLS
NONE

G. MASONARY ORNAMENTATION CANTILEVERING FROM URM WALL FACE
YES- MASONRY CORBELING AT PARAPETS AROUND SOUTH AND WEST ELEVATIONS

II- EFFECTIVE PEAK ACCELERATION- 0.2 G.

A. VERTICAL LOAD CARRYING SYSTEM CONSISTING OF A NON DUCTILE CONCRETE BEAM AND COLUMN SYSTEM THAT PROVIDES VERTICAL SUPPORT FOR A URM WALL THAT IS NOT CONTINUOUS TO THE BASE OF THE BUILDING
NO

B. VERTICAL LOAD CARRYING SYSTEM CONSISTING OF STEEL BEAMS SUPPORTED ON MASONARY PIERS OR COLUMNS THAT PROVIDES SUPPORT FOR A URM WALL THAT IS NOT CONTINUOUS TO THE BASE OF THE BUILDING
YES- SECOND FLOOR FRAMING OVER MAIN LOBBY AREA PROBABLY CONSISTS OF IRON BEAMS SUPPORTED BY URM PILASTERS ON THE EXTERIOR WALLS- INTERIOR WALLS APPEAR TO BE TIMBER; HOWEVER UDW-F

III- EFFECTIVE PEAK ACCELERATION- 0.4 G.

A. ALL URM WALLS WITH OR WITHOUT OPENINGS THAT EXTEND UPWARD FROM THE BASE OF THE BUILDING
NOT APPLICABLE

B. ALL URM WALLS WITH OR WITHOUT OPENINGS FOR DOORS AND/OR WINDOWS THAT ARE NOT CONTINUOUS WITH THE BASE OF THE BUILDING
NOT APPLICABLE

IV- UNUSUAL OR SPECIAL CONDITIONS

A. SPECIAL CONSIDERATIONS
NONE

B. OTHER ELEMENTS
NONE

That checklist was used for the visual inspection of all buildings. Thus same criteria were applied to all of the buildings and common information created for all structures. The checklists of all the surveyed buildings are included in the appendix.

From the field survey forms the research team identified any potential hazardous building elements that existed for each building. The hazardous elements identified were those elements listed by ABK for effective peak acceleration areas of 0.10 and 0.20 respectively, as appropriate for the various regions of Washington and Oregon. Building owners were informed of the hazardous elements that existed in their buildings. However the information they received stated only that such elements existed the hazards were not evaluated. Recommendations for mitigation were only made when it was obvious that immediate hazards existed, in all other situations it was recommended that a thorough engineering evaluation be given.

The identification form listed only building elements that may be at risk during a seismic event. The other factors which may have significant influence (i.e. local soil conditions) were not identified.

By visual inspection the building elements,and the important parts of the structure that were accessible, were examined. No removal of finishes was attempted. In many circumstances this visual inspection could not provide sufficient enough information for any definitive judgments about the building's performance during a seismic event.

Conditions of deterioration or decay were observed and and conclusions drawn as to the likely general conditions of buildings of this type in small towns in the Pacific Northwest.

C. Study Limitations

It was envisaged from the start of the study that it would be the first step in a more comprehensive study involved in identifying and mitigating the potential hazards of unreinforced masonry buildings in small towns. Although 35 buildings in seven towns were examined and although the team was able to find similar hazards in almost all towns only one type of building was examined--"the turn of the century unit masonry structure." Other types of buildings of differing construction and age could exhibit similar potential hazards and should be included in future surveys. The study team was not,because of time constraints and access to structural details, able to do a complete structural analysis of the case study buildings. Therefore the team could not offer specific recommendations to owners or officials on anything more than the obvious and most potentially threatening elements. Further the team visually inspected the case study buildings as part of our checklist methodology, but did not carry out any testing of masonry walls, piers, or other building elements.to establish specific material properties of specific buildings. Any more comprehensive analysis would require such material property tests and a thorough analysis by a structural engineer. It should also be noted that the local soil conditions which could amplify or dampen seismic effects were not considered as an element of the survey because of time constraints and lack of appropriate geologial and geotechnical data.

II. SUMMARY OF FINDINGS

A) Administration of Building Codes and Enforcement

The record of building code enforcement varied widely in the seven study towns. However in all seven towns the building department had difficulty when it came to enforcing the code in the older existing unreinforced masonry buildings. The Uniform Building Code is written primarily for new construction and when applied to existing older URM structures provides few guidelines that can aid small town building departments or owners.

a) Code Enforcement

Some towns relied on the county to handle their enforcement and plan review, (Jacksonville, Oakland, and Bellingham) while others had their own building department and an official who enforced the code. All the communities studied had adopted the latest version of the Uniform Building Code, as required by state law, but enforcement was very inconsistent.

In Port Townsend, for example, a building permit was not required for URM buildings, a policy established by their building department several years ago. It was discovered, as a result of interviews with current and former building officials, town and country planners, and the city attorney, that this lack of building code enforcement could be attributed to two major factors:

1) The older unreinforced masonry buildings could not meet the requirements of the building code and the building department did not have the knowledge to implement

seismic provisions; and

2) A political decision had been made not to enforce the codes because it was important for the town's economy (which was over 40% dependent on the tourist trade) that those buildings retain as much as possible the original character.

In the other towns studied, enforcement of the building codes for URM structures, especially when it came to enforcing seismic provisions, was very uneven. In only three buildings out of the seven towns and thirty-five buildings examined, in detail, had there been rehabilitation with significant seismic provisions. Most URM buildings in those towns had parapet and appendage hazards that had not been addressed.

The lack of knowledge on how seismic considerations should be applied to URM buildings was common in every town except Vancouver and where there was an awareness of the seismic hazards of URM buildings and local structural engineers with expertise in seismic design. The rehabilitation plans that were provided to the building department by three of the case study buildings owners included seismic reinforcement specifications. But in general the other small town building departments did not have the knowledge to recommend to owners what seismic considerations should be taken into account during a rehabilitation, nor were plans presented to the department that contained seismic specifications.

In each town there were URM buildings that had not been rehabilitated fully but were in use. Typically the ground floor had been rehabilitated and again placed into use but nothing had been done to the upper floors of the structure. Yearly maintenance had occurred to keep the ground floor rentable but capital expenditures had not been made to upgrade the entire building. In such cases of partial use of a building, the building department did not enforce the code or require that seismic considerations be applied.

b).Code Enforcement Entity

Two code enforcement options were observed in the small towns. Either the town would hire their own city building official or an official at the county level would administer the code for the town. Vancouver, Port Townsend, McMinnville, and Ellensburg had their own building official. Jacksonville, Oakland, and Bellingham had county building officials. The following chart summarizes the local government organization and enforcement policies affecting the older and historic URM buildings. It is marked figure 1 .

Political pressure can be exerted on building officials by owners and other city officials when it comes to applying a code to URM structures. It was apparent from discussions with building officials in these towns that they could not realistically force owners to correct potentially hazardous conditions or strictly enforce the code by abating the hazard through condemnation without a city policy specifically directing them to do so.

	Local Government	Building Code Administration	Enforcement Policy
Port Townsend	Council/mayor	--City Code	UBC enforced on new construction no permit/inspec tion of Rehab
McMinnville	Council/Mayor	--City Code --State Code sec. 4903 code waiver in historic bldg	State Amended UBC applied,permit required,no seis mic mitigation
Vancouver	Council/Manager	--City Code --City code waiver for historic buildings	UBC enforced on new construction seismic design for Rehab
Ellensburg	Council/Mayor --Historic Pres. Review Comm.	--City Code	UBC enforced. permit required no seismic mit-gation required
Jacksonville	Council/Mayor --Historic Pres. advisory coun.	--County Code --Property tax freeze for his-toric buildings	State Amended UBC applied,permit required,no seis mic mitigation
Oakland	Council/Mayor	--County Code	State Amended UBC applied,permit required,no seis mic mitigation
Bellingham	Council/Mayor	--City Code (recent code enforcement switch)	UBC enforced. permits required no seismic miti-gation program

Figure 1. Chart identifying the government organization and code administration policies for study towns

Two code enforcement situations existed in these towns that could be identified:

...Building officials in many situations,and by their own admittance did not have the knowledge to enforce seismic provisions in URM structures and

...Because the town's economy was primarily dependent on the continued use of URM structures potential seismic hazards were allowed to exist in occupied buildings.

B. Historic and Economic Profile of Towns and Their Relationship to the Application of Seismic Provisions in URM Buildings

One of the research objectives identified in the introduction to the report was clarification of how the history and economic condition of the study towns could directly or indirectly affect the application of codes by building officials, and affect the condition of the stock of unreinforced masonry buildings in those towns.

Historic Factors. Though each town had a distinctly different history many historical situations were similar, and the similarity was often reflected in the condition of the brick buildings. The photographs of (figure 2) identify the transition from wood frame to unreinforced masonry that was typical in every town after fire destroyed the original buildings. Some of those similarities are as follows:

a) **The URM buildings built before 1900 were typically built during periods of growth and speculation in the small towns,** as rivalries between other towns and rapid change occurred at the turn of the century in the Pacific Northwest. Buildings were often constructed quickly as a showpiece to the railroad.

b) **Fire often preceded the building of the URM structures.** The original wood frame buildings of the mainstreet were destroyed, and immediately followed with the construction of brick buildings, often within a year or less of the fire.

c) **The building technology for pre-1900 structures was almost identical for each of the towns** in the use of wood for interior framing and local fired brick of varied quality for exterior walls.

d) **There were periods within each town when a large number of the URM buildings had high vacancies,** were under maintained, and were threatened by deterioration or demolition.

e) **Many of the URM buildings in the town were destroyed and replaced.** The existing stock represents the survivors and their condition often reflected long periods of deterioration and lack of use.

f) **Many URM buildings have undergone no significant rehabilitation since they were built.** The ground floor space is occupied but many of the upper floors are vacant , the use of space determined most typically by the economic cycles of the town

<u>Summary of Economic Conditions</u>. It was found as the research progressed, that the economy of the towns influenced both the level of expenditure by owners on rehabilitation and the level of enforcement by building officials within the community. Owners could not expend more than they could expect to return from rent in a building; and building officials could not realistically require an owner to expend more than that owner's resources

Port Townsend before 1900. Typical Collection of Woodframe Buildings that Composed the Mainstreet of the Seven Study Towns

Port Townsend Early 1900's. Typical Replacement of Woodframe Structures with Unreinforced Masonry after Fire Spread Through Town. In every Study Town this Situation was the Same.

Figure 2. Transition of Woodframe to Unreinforced Masonry

allowed to retrofit the building to reduce potential hazards. The town economy and level of maintenance or rehabilitation were intertwined. The following observations were made:

a) **The traditional economies of the small towns that existed when the URM buildings were constructed could no longer suppport the labor force of the population.**

b) **In every town the team studied it was found that an economic incentive existed to attract non-residents to town** as tourism became a significant component of the economy and the traditional industries waned.

c) **The promotion of the historic character of the buildings was a strategy for economic development** of the town leaders, and shops and services oriented to tourists were established in the older existing buildings.

d) **As the economy in the towns improved owners were able to expend more on the rehabilitation of their buildings** and develop a market for improved space. As the economy declined and vacancies occurred in buildings it became costly to maintain buildings, or to rehabilitate them for new uses.

e) **In every town studied there existed URM buildings with unoccupied upper floors.** A market for this space could not be established by owners and therefore this space was not renovated.

f) **The rehabilitation of the URM structures was in most cases dictated by the space to be rented,** with cosmetic alteration to rentable space and very little structural reinforcement for the building as a whole.

g) **The value of the building was determined by comparable sales,** or the income that could be generated by space in the building; **the structural condition of the building was not a factor that was considered in value** determination when buildings were sold.

h) **Economics determined rehabilitation.** An owner rehabilitated a building on the basis of rent that could be generated. Rehabilitation was not undertaken specifically to reduce potential structural hazards.

The potential seismic hazards in the case study buildings could not be attributed to one specific cause and it was the interplay of historic, economic, and ownership characteristics that affected the condition of the unreinforced masonry buildings.

Though the Effective Peak Acelleration (EPA) was an important factor in the identification of the probability of a seismic event occurring in a specific zone, other factors such as deterioration and lack of maintenance could weaken a building, making it less resistant to even low intensity earthquakes in relatively inactive seismic areas.

Therefore the potential sesimic hazards that exist in URM buildings must be investigated with not only the EPA of the locality in mind but with an understanding of the interrelated factors that relate to the structural conditions of unreinforced masonry structures.

A diagram depicting these interrelated factors is included marked figure 3. on page 19.

C. Seismic Risk in Washington and Oregon and the Potential Hazards of Unreinforced Masonry Buildings in the Study Towns

Seismicity in Washington and the Puget Sound

The Puget Sound Region in Washington is an active seismic region because it is affected by the movement of the North American and Pacific Plates as is California. Tectonics is the geology of this type of plate movement and the deformation of

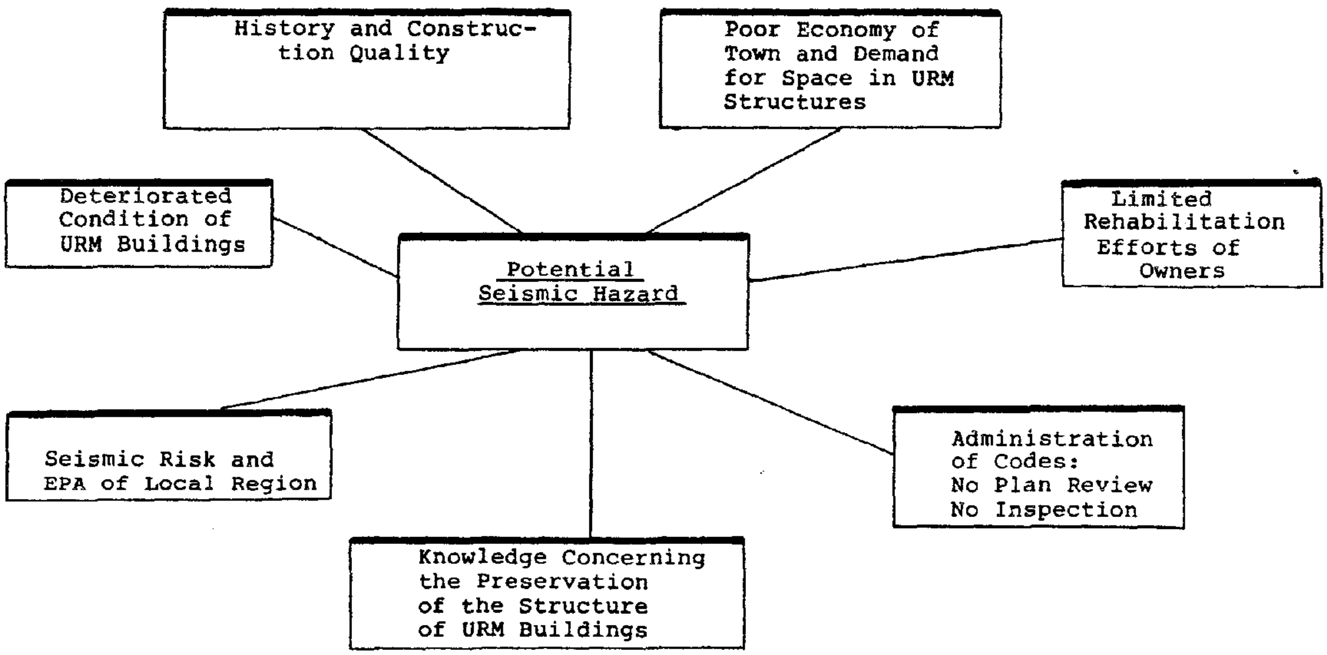


Figure 3. Diagram identifying the factors that affect the potential seismic hazards in unreinforced masonry buildings. Economic, historic, and ownership characteristics all impact the condition of buildings in small towns and the strength of these buildings to withstand earthquakes.

the earth's crust along fault lines. Generally, the seismicity of the Puget Sound is determined by plate tectonics. The San Andreas Fault and, farther north, the Queen Charlotte Island Fairweather Fault mark the intersection of the two plates. Subplates like the Juan de Fuca plate interact with the North American Plate and it is the activity of plates and subplates, their interaction and their deformation that provide a clue to the seismicity of the region.[1]

Because of the dynamics of plate activity and the boundary conditions between them, stress and related earthquakes will occur. As concluded in the study by the USGS on earthquake losses in the Puget Sound:

> Puget Sound is uniquely positioned in terms of tectonic evolution of the Pacific Northwest, and consequently we must expect a high level of seismic risk from subcrustal earthquakes occurring here.[2]

Figure 4 identifies the plate interaction off the west coast affecting Washington and Oregon.

Though the tectonic activity is not well understood, earthquakes are associated with where plates meet. The most damaging earthquakes are those related with surface faults where a rupture of the earth's surface occurs. "Faults represents zones of crustal weakness, and seismic events have been, are, and will continue to be related to them.[3]

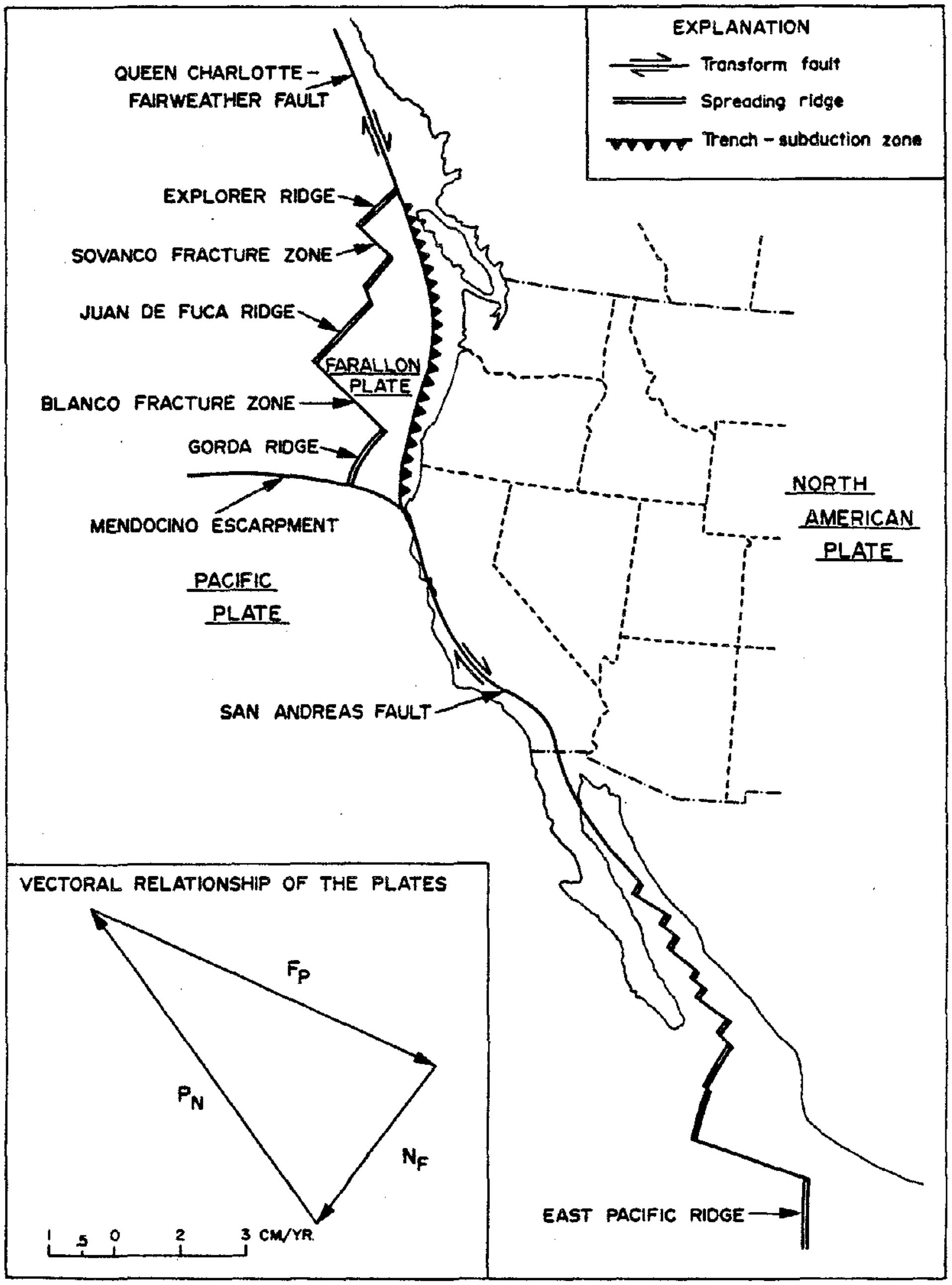


Figure 4. Plate tectonic setting of Oregon and Washington (Beaulieu,State of Oregon Dept.of Geo.& Mines)

In the Northwest the damaging earthquakes have been located well below the earth's surface at much deeper levels where fracturing and slipping occurs without breaking the surface. No surface faulting was observed after any of the large Washington earthquakes. As a result of this condition it is very difficult to map fault lines in the Puget Sound; this limits the prediction of future shocks in any specific location. A damaging event therefore might occur in unexpected locations.[4]

The Puget Sound is an active region and it has experienced over 1,080 felt earthquakes in the past 135 years. The two major quakes that produced the greatest amount of damage occurred in Washington on April 13, 1949 and on April 29, 1965.

The 1949 Earthquake

The earthquake of 1949 demonstrated that large earthquakes of damaging force could occur in the Puget Sound. The earthquake was centered about 40 miles southwest of Seattle; a 7.1 on the Richter Scale and the strongest felt quake in the U.S. at that time since the San Francisco quake of 1906. The property damage was extensive at between $15 million and $20 million dollars.[5]

As described by the report issued by the American Society of Civil Engineers the earthquake affected mostly the older masonry buildings: "Some masonry structures with wood frame interiors suffered quick and heavy damage. The inadequacy of the lime mortar of the early days was again demonstrated, while strong mortars and encircling reinforced concrete bond beams showed their worth. Poorly designed simple framed structures without ties failed."[6] In Pioneer Square in Seattle the older buildings that suffered the greatest damage were those built in the 1890's with inferior brick, weak mortar, badly anchored floor and roof joists, and three to five story structures with many openings in the walls. These were the typical type of building we surveyed in the study towns.

The 1965 Earthquake

The July 29, 1965 earthquake was felt over 130,000 square miles and observed as VII on the Modified Mercalli Scale and 6.5 on the Richter Scale. Damage was negligible in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures. Property loss in 1965 was estimated to be approximately $12 million, with damage patterns repeating the 1949 earthquake. Many buildings that had suffered significant structural damage in 1949 quake sustained greater damage than most in the 1965 quake.

The following map, figure 5 identifies the location of the major earthquakes that occured in Washington over the last 100 years. Figure 6 is the listing of the larger earthquakes in Washington over the last 150 years, a more complete listing and a Modified Mercalli Intensity Scale is included in the appendix. Three of the study towns, Ellensburg, Port Townsend, and Bellingham are listed as towns that experienced earthquakes.

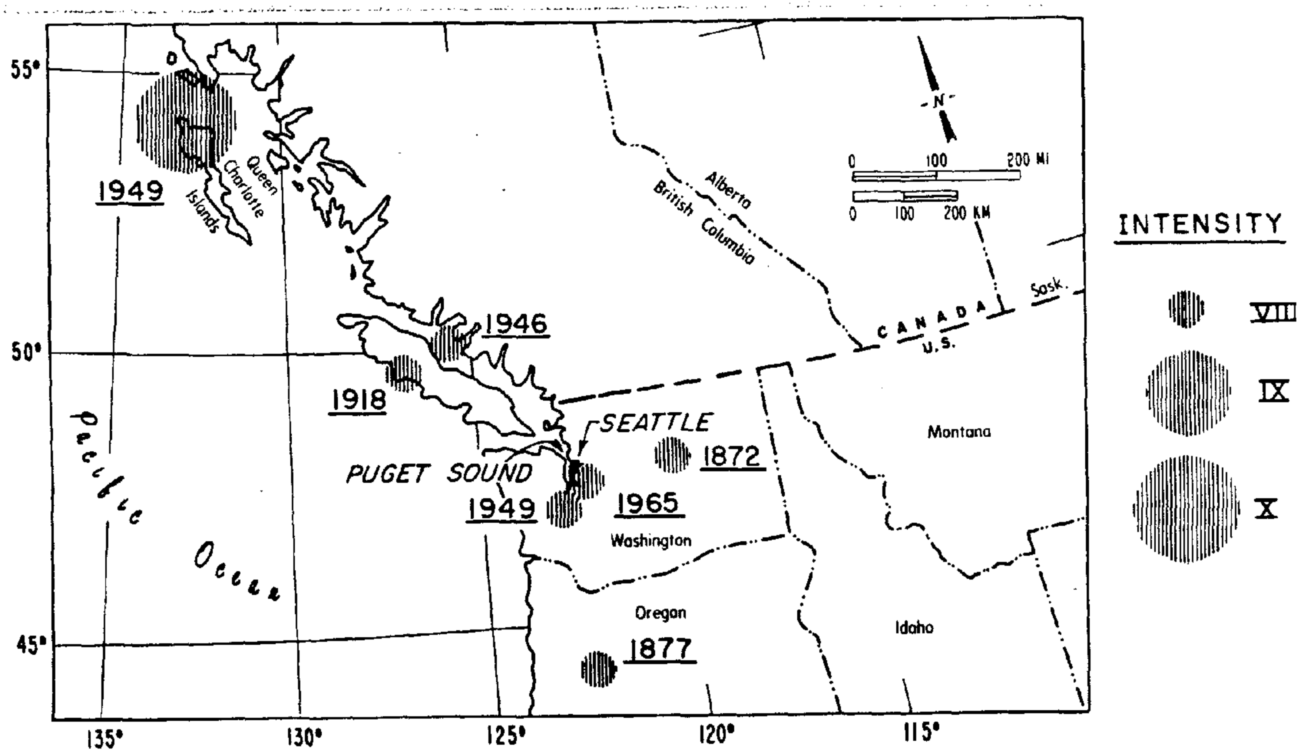


Figure 5. Principal earthquakes affecting Puget Sound area historical times. (USGS Report 75-375)

Principal Earthquakes Affecting the State of Washington

Year	Date	Intensity	Comments
1872	Dec. 15	VIII+	Severe shock at Olympia strongest near Wenatche e/Chelan.Felt Oregon to B.C.
1877	Oct. 12	VIII	Cascade Mountains, Ore. Chimneys thrown down
1918	Dec. 6	VIII	NW Wash. Severe in Victoria, felt in Seattle
1949	Apr. 14	VIII	Olympia.All large buil-dings in Olympia damage Heavy property damage over a wide area of Washington and Oregon
1949	Aug. 22	X	Queen Charlotte Islands Felt from Portland to S. Alaska
1965	Apr. 29	VIII	Seattle. Extensive damage, seven killed $12.5 mil. damage

Figure 6. Listing of major Earthquakes in Washington (USGS Report 75-375)

Seismicity in the State of Oregon

Oregon is located between two states which have had a history of major earthquake activity and within the tectonic influence of the coastal plates,but the state has not experienced major damage because of an earthquake in terms of property damage or loss of life. The largest earthquakes in Oregon occurred in 1873 in the Klamath Mountains of intensity VIII and in 1877 in the Cascade Range also with an intensity of VIII but settlement and building construction was limited and damage therefore minimal.

The greatest frequency of earthquake activity is in the Portland area with an intensity V quake per year. The earthquake epicenter locations of Oregon earthquakes since 1840 are displayed in figure 7. They are described by physiographic area and frequency. Seismically active areas exist within Oregon but these regions have exhibited earthquakes with less intensity and frequency then Washington or California.

The record of past events is relatively short, and the more accurate monitoring by seismograph stations has only occurred in the last 20 years. The picture of the seismology of the state is therefore uncertain. With the tectonic activity affecting the west coast the seismology and pattern of earthquake events in Oregon could change. A recent earthquake on March 14, 1985 was centered off the Oregon coast on a fault that connects the Gorda and Juan de Fuca Ridges registering a 6.1 on the Richter Scale. Fig. 8 identifies intensity and location of past major events.

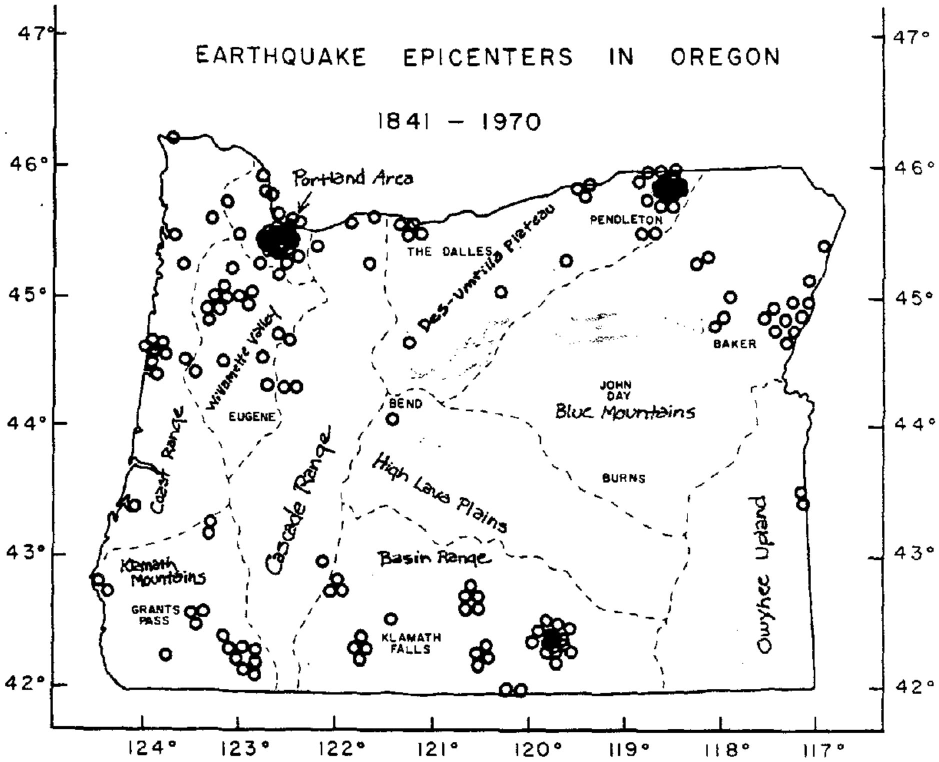


Figure 7. Earthquake epicenters in Oregon 1841 through 1970
The dashed lines delineate physiographic areas.
(Couch 1971)

Physiographic Area	Maximum Intensity+	Maximum Acceleration (cm/sec^2)	Years of Maximum Intensity	Average E/yr(E=ERG) 1870–1970	Average E/yr/km^2 1870–1970	Estimated Seismic Activity Level
Portland Area	VII	68.1	1962	2.6×10^{17}	8.7×10^{13}	One magnitude 4.8*(intensity V) quake per year; or One magnitude 5.3*(intensity VI) quake per ten years
Coast Range	VI	31.6	1957 1963	6.4×10^{16}	3.4×10^{12}	One magnitude 5.0*(intensity V) quake per ten years
Willamette Valley	VI	31.6	1896 1930 1961	1.3×10^{17}	9.6×10^{12}	One magnitude 5.3*(intensity VI) quake per thirty years
Klamath Mountains	VIII	147.0	1873	2.8×10^{18}	1.8×10^{14}	Insufficient Data
Cascade Range	VIII	147.0	1877	2.7×10^{17}	9.6×10^{12}	Insufficient Data
Deschutes-Umatilla Plateau	VII	68.1	1893 1936	8.4×10^{17}	4.4×10^{13}	One magnitude 5.7*(intensity VI-VII) quake per forty years
Basin and Range Province	VII	68.1	1968	8.8×10^{16}	3.3×10^{12}	One magnitude 5.2*(intensity V-VI) quake per twenty years
Blue Mountains	VI	31.6	1913 1969	6.6×10^{16}	1.1×10^{12}	One magnitude 5.1*(intensity V-VI) quake per fifteen years
High Lava Plains	III	3.2	1943	2.4×10^{13}	1.1×10^{9}	Insufficient Data
Owyhee Upland	IV	6.8	1944	2.0×10^{14}	6.9×10^{9}	Insufficient Data

+ Modified Mercalli Scale (1956 Edition)
* Unified Magnitude Scale

Figure 8. Earthquake Characteristics in Oregon (Couch 1971)

Effective Peak Acelleration

The Effective Peak Acceleration or (EPA) can be used as an identification of the seismic risk in URM structures. The EPA is a numerical value associated with the intensity of ground shaking and was established by Applied Technology Council (ATC) based on research into past seismic events. The EPA values are the probability of an earthquake occurring causing the designated ground acceleration in that region once in 50 years. The EPA values are expressed in fractions of the acceleration due to gravity. EPA values have been mapped and can be referenced in planning for the mitigation of hazards in existing structures. Those values represent the effective acceleration for bedrock and must be adjusted when appropriate, for local soil conditions. Such conditions can magnify the EPA value for a specific site.

ATC 3-06 identifies Effective Peak Acceleration values on a county by county basis for the entire United States. Investigations have demonstrated repeatedly that earthquake building damage within a small region can vary significantly with varying soils conditions.

Other influences create substantial variations in predictions of damage. These include the depth of the quake, the location of the epicenter relative to building , the quakes duration, and the buildings orientation. In any evaluation seeking to establish a strategy for seismic reinforcement of a particular building such local effects must be taken into consideration, and consideration also given to historic facts.

The seismic zone map as published in the Uniform Building Code relates specifically to new construction and does not relate to the intensity of ground shaking (EPA) and resultant likely impact on existing URM buildings and building elements. In terms of identifying risk and the potential hazard of buildings in the study towns, the study team chose to identify risk in terms of Effective Peak Accelleration (EPA) and not in terms of the UBC risk map. Within the state of Oregon and Washington the EPA varies from 0.05 to 0.20. The ATC 3-06 map is included as Fig. 9

The study towns with the greatest probabilty of future earthquake activity were in Washington and included Port Townsend, Ellensburg, and Bellingham. Conversely, the Oregon towns of Oakland, Jacksonville, and McMinnville were less likely to experience an earthquake of damaging force.

The EPA values for the towns are listed below. The higher the number the higher the probability. These probability values are important to identify since appropriate mitigation measures should take into account the likely magnitude of the siesmic event. It should, however, be noted that those values are not construed with known historic events in the nineteenth century and with the known tectonics of the region.

Study Town	Effective Peak Acceleration (EPA)
Washington	
Port Townsend	0.2
Bellingham	0.2
Vancouver	0.1
Ellensburg	0.2
Oregon	
Jacksonville	0.05
Oakland	0.05
McMinnville	0.05

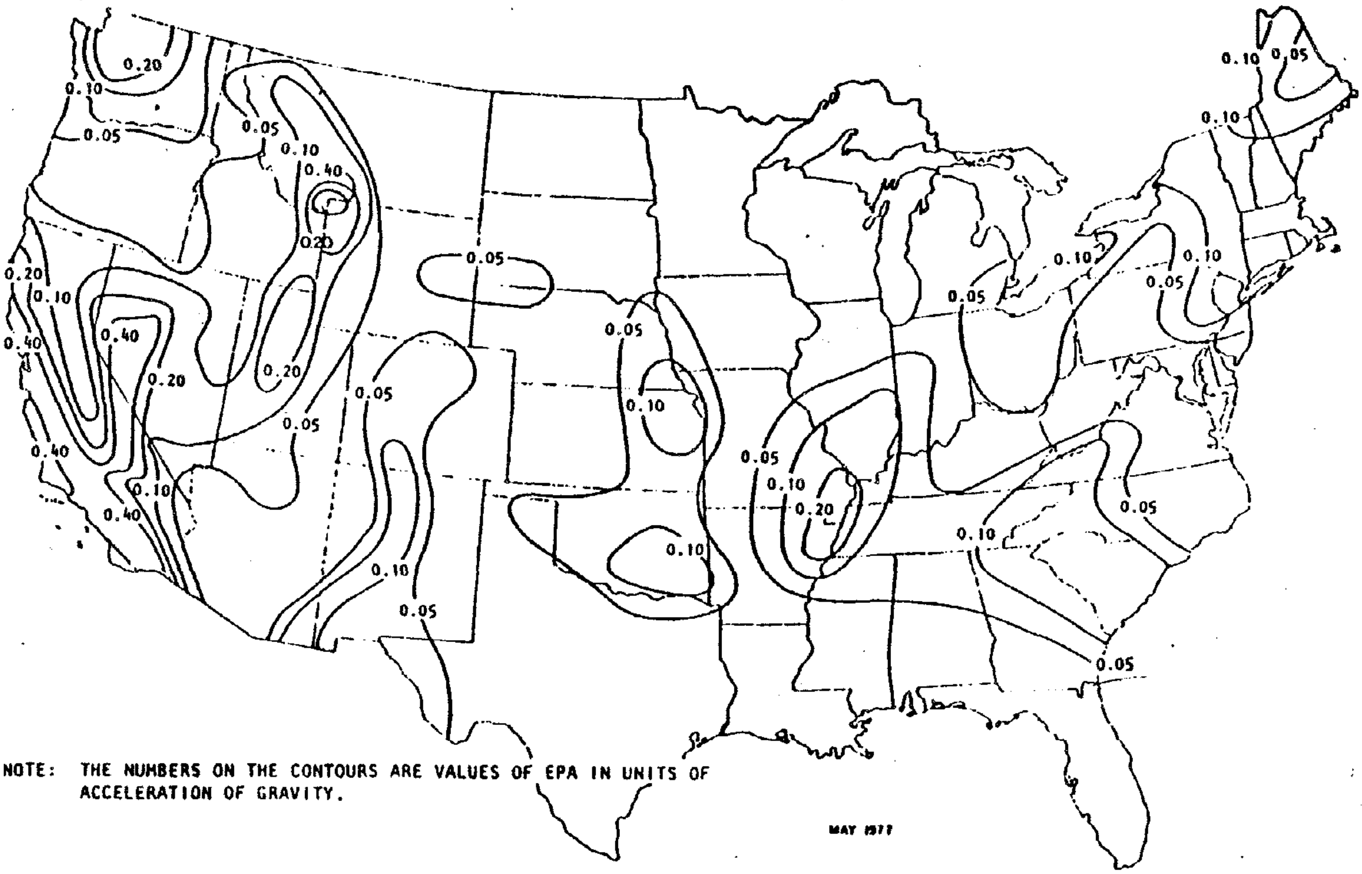


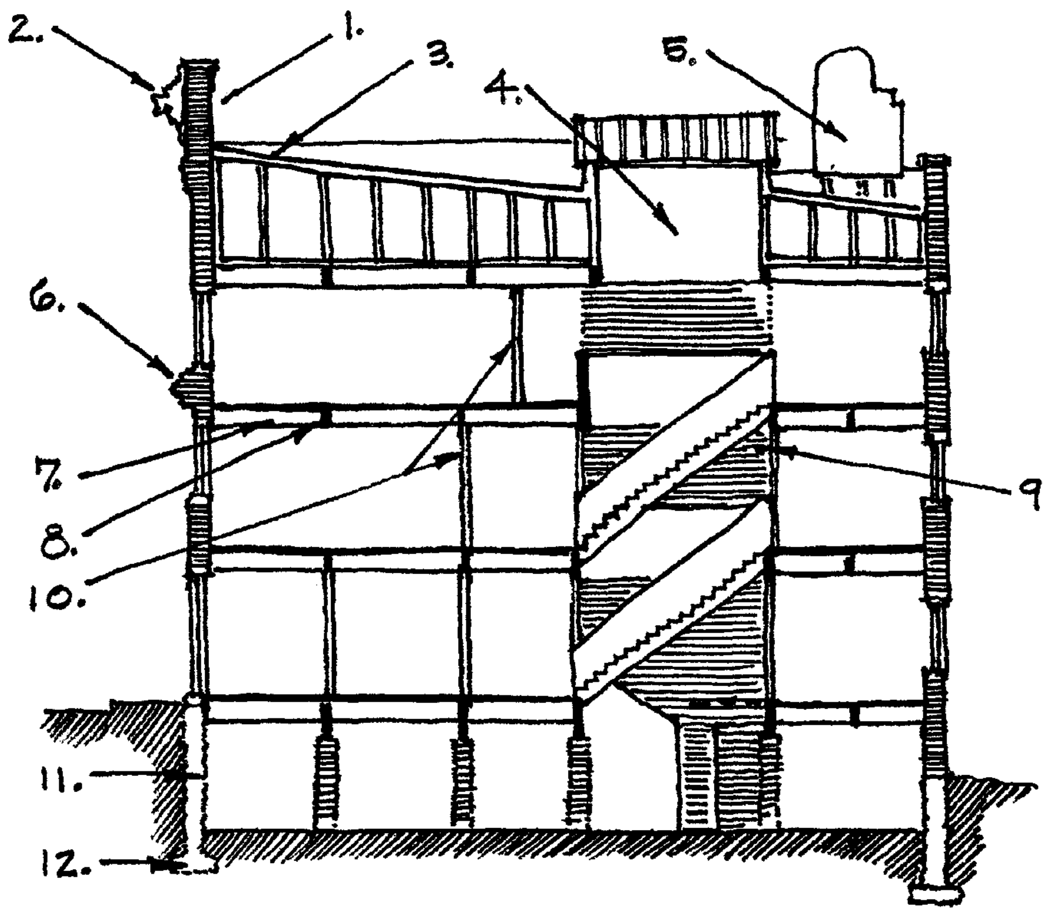
Figure 9. Contour Map For Effective Peak Acceleration (ATC 3-06 ,1978)

Potential Hazards in URM Buildings in the Study Towns

The Hazards of Unreinforced Masonry

The typical turn of the century unreinforced masonry structures were often built quite similarly in the the study towns: with timber framing of floors, interior walls, and foundation joists and beams, and brick and lime mortar forming the exterior load bearing walls. In almost every building surveyed and in the majority of other URM buildings in town of the same era, no reinforcement, the tying of and securing of brick walls or appendages, occurred to reduce the possibility of failure or separation of building elements during an earthquake. A section of a typical unreinforced masonry building and building elements is included and marked as figure 10.

Unreinforced masonry buildings elements that are not properly tied together offer little resistance to earthquakes and their resultant forces. Though many of such buildings have stood, seemingly undamaged for several decades, their survival through previous minor events does not mean that the building is likely to survive subsequent major events. In fact damage due to previous minor events, and general deterioration, if left unrepaired increases the likliood of catastrophic collapse in a subsequent major events. Figures 11 through 14 detail the unreinforced masonry building elements that have been shown to be the most



Section of Unreinforced Masonry Building and Elements Fig.10

1. Untied Parapet
2. Cornice (masonry or applied)
3. Roof Diaphragm
4. Light Well
5. Rooftop load
6. Masonry beltcourse
7. Floor joist
8. Beam
9. Areas of Unbraced masonry wall
10. Discontinuous wall planes
11. Rubble Foundation wall
12. Footing

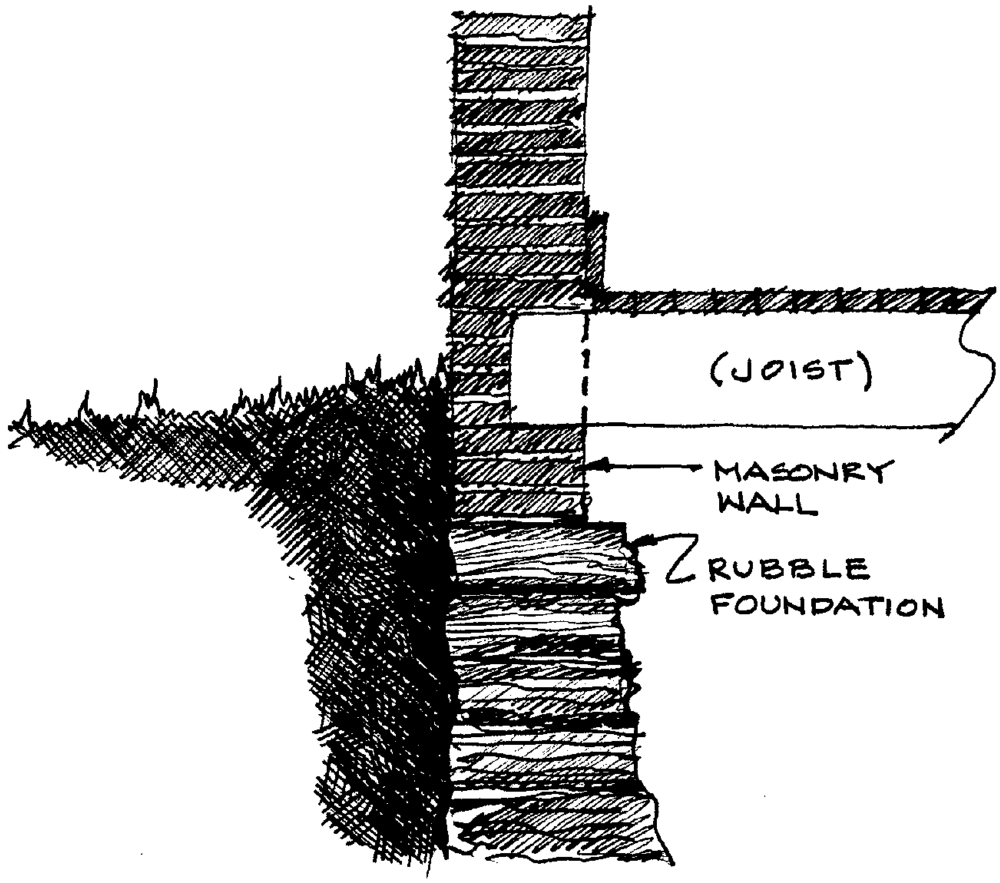


Figure 11. Diagram depicting what was a common condition found in many of the survey buildings. Rotten joist ends, water damaged masonry, poor wall/ foundation connection

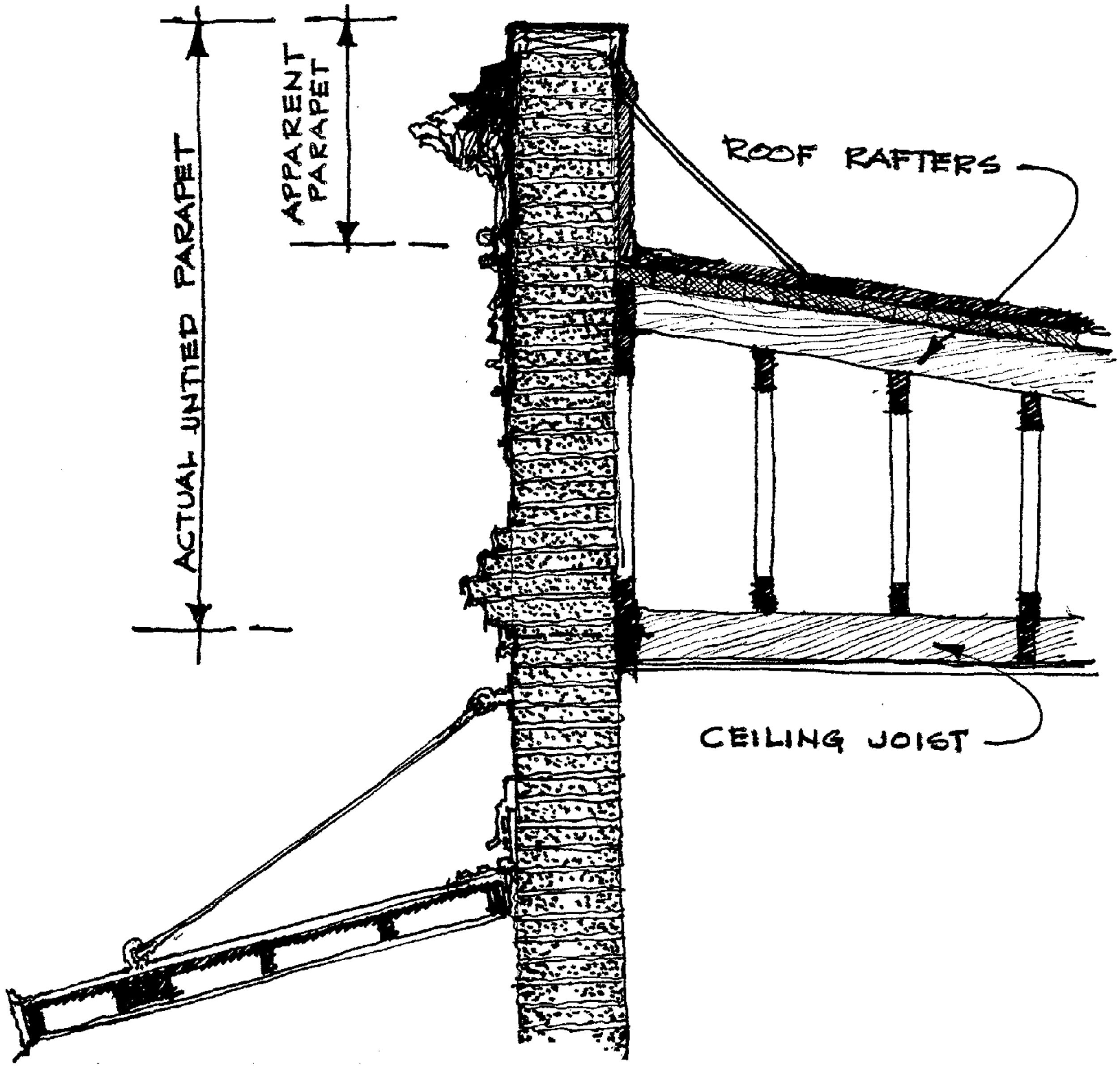


Figure 12. Section of typical parapet extending untied from the upper floor. The apparent parapet height is only to the rafters but in fact it extends in many cases 6 feet to the ceiling joists. In many cases the joists simply pocket into the brick and there is no tying of parapet to flooring

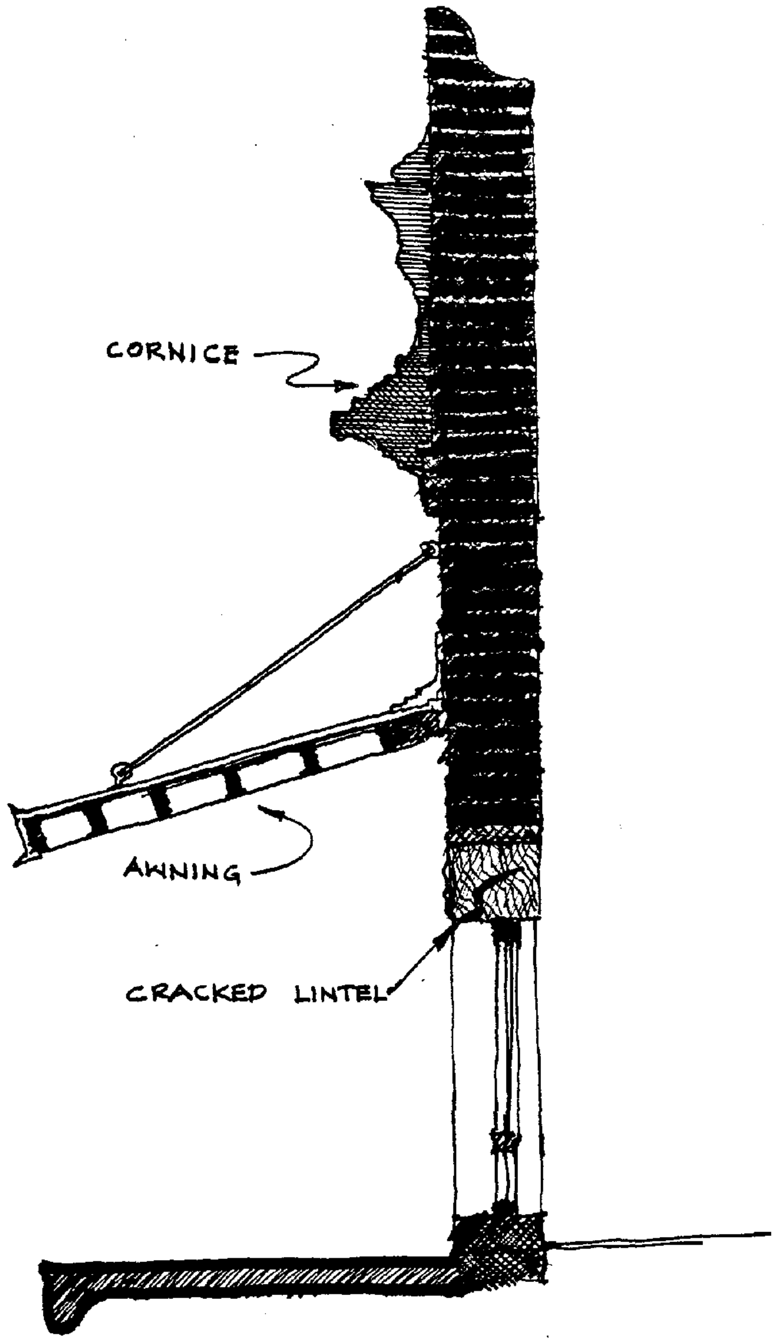


Figure 13. Section of unsecured appendages that appear on many unreinforced masonry buildings. These appendages in the case study buildings in some instances were deteriorated and in some cases overhung the public sidewalk or street.

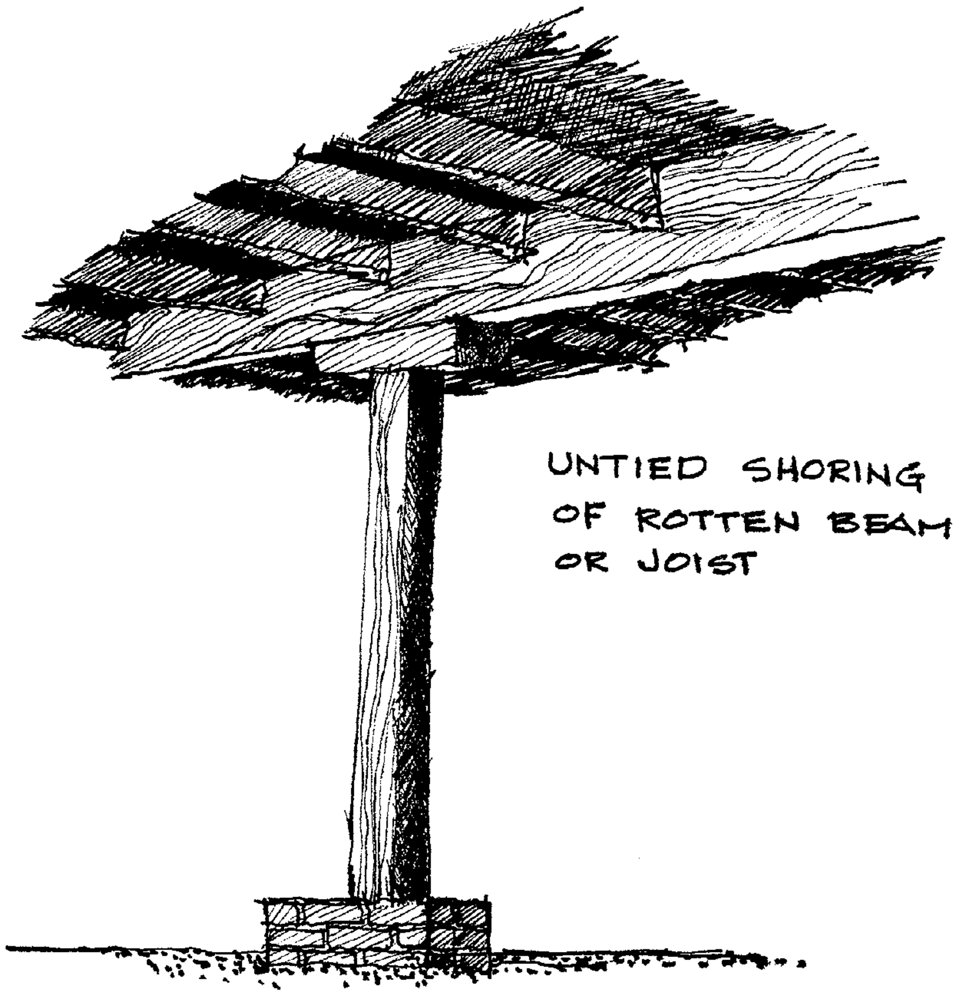


Figure 14. Diagram of shoring of joist or beam that had become rotten because of the presence of water and the lack of ventilation in basement foundations. This condition of shoring was was found in many of the case study buildings. The shoring was typically untied and may not withstand the strong lateral forces that could occur with an earthquake.

hazardous in similar building types in past earthquakes. These unsecured appendages, walls, and unreinforced foundations offer little resistance to the lateral forces that are exerted during an earthquake.

All of the buildings examined during this survey were built prior to much of the current legislation which seeks to protect property and protect the public from seismic damage or even general structural collapse. The assembly techniques employed in these structures seldom provided any resistance to lateral forces. Many of the building visited revealed noticeable deterioration of mortar and brick, significant settlement, sandblasting for appearance purposes and hence exposure of unprotected masonry, and rot in floor framing systems that presented the possible danger of gravity load failure alone, or a gravity load failure during a relatively minor seismic event or severe wind storm.

In all the towns the team studied potential hazards existed in the unreinforced masonry buildings, only in two towns had an awareness of seismic hazards been demonstrated by the reinforcement that occurred in three of the case study buildings. Figure 15 identifies all the buildings in the survey and the potential hazards that were documented. This is a general listing, the case study survey of hazardous elements of each building is included in the appendix.

Deterioration of URM Building Elements

Deterioration of URM building elements was identified as a component of the survey of case study buildings. The absence of

	Did Potential Seismic Hazard Caused By Deterioration of URM Building Elements Exist?	Are There Unreinforced Masonry Appendages Existing: Parapets, Cornices, Chimneys?	Were Seismic Mitigation Measures Observed: Tying, Abatement, Seismic Design Applied
Vancouver (EPA .10)			
Buildings:			
The Evergreen	No	No	No
The Esther	No	No	Yes
The Main	No	Yes	No
The Mill Plain	No	No	Yes
The Daniel	Yes	No	No
Mcminnville (EPA .05)			
Buildings:			
The Cedar	No	Yes	No
The Western	Yes	Yes	No
The Gateway	Yes	Yes	No
The Shady	Yes	Yes	No
The Holly	Yes	Yes	No
Port Townsend (EPA .20)-			
Buildings:			
The Water	No	Yes	Yes
The Adams	Yes	Yes	No
The Haven	No	No	Yes
The Tidepool	Yes	No	No
The Dock	Yes	Yes	No
Ellensburg (EPA .20)-			
Buildings:			
The Rodeo	No	Yes	No
The Sprague	No	Yes	No
The Alder	Yes	Yes	No
The Pine	Yes	Yes	No
The Willow	Yes	Yes	No
Jacksonville (EPA .05)-			
Buildings:			
The Laurelwood	No	No	No
The Maple	Yes	Yes	No
The Stagecoach	No	Yes	No
The Miner	Yes	Yes	No
The Woodberry	Yes	Yes	No
Oakland (.05)-			
Buildings:			
The Apple	No	Yes	No
The Turkeywing	No	No	Yes
The Oak	Yes	Yes	No
The Cedar	Yes	Yes	No
The Valley	Yes	Yes	No
Bellingham (.20)-			
Buildings:			
The Bayview	No	No	Yes
The Kentucky	Yes	Yes	No
The Garden	No	Yes	No
The Park	No	No	Yes
The Canadian	No	No	No

Chart of all Survey Buildings in Study Towns and Identification of General Potential Hazards and Mitigation Measures Applied to Each Building. (The actual names of the buildings are not identified, the names shown are fictitious and any similarity to an existing building is coincidental)
Fig. 15

continual maintenance and weathering of the buildings increased their potential seismic hazard even in the relatively low risk earthquake towns.

In a high percentage of the buildings inspected in the several towns significant structural deficiencies were found which were potentially serious seismic hazards. Some of the more common potential hazards found during the survey included: deteriorated parapets and untied cornices and appendages, URM walls not tied to floors and roof joists, major spalling of the brick, eroded or nonexistent mortar joints, and deterioration of structural timber. The survey form of each building is included in the appendix which identifies the potential hazards that were observed in the case study buildings. The following photographic documentation that is incorporated into the text figures illustrates the typical hazards that were identified in the study town buildings.

Potential Hazard

Unreinforced Masonry Building Components

URM

--An example of untied parapet wall,no ties of walls to floors

--Spalling and cracking of brick in URM wall is revealed

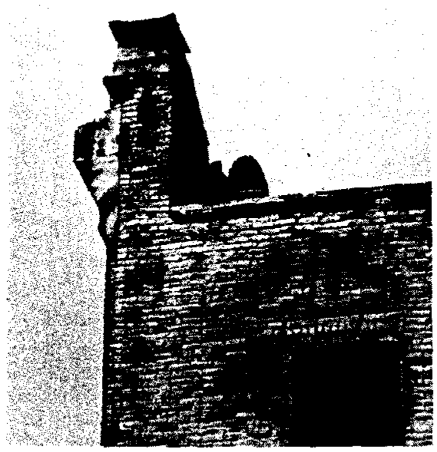


Fig. 16 (Port Townsend)

In the study towns of Bellingham, Port Townsend, and Ellensburg with an EPA of .20 the lateral forces of an earthquake could potentially cause the separation of unreinforced masonry elements such as appendages that exist above the uppermost anchorage point and URM walls unsecured at the floor. Physical separation of this nature would pose a considerable hazard to persons at street level. Since virtually no hazard mitigation measures were taken in most study towns this coupled with severe deterioration of the building elements could cause the failure of appendages and URM walls as a result of distant earthquakes or other intensity lateral forces such as wind.

Potential Hazard

Unreinforced Masonry Building Components

URM

--An example of an unreinforced masonry wall overhanging public street

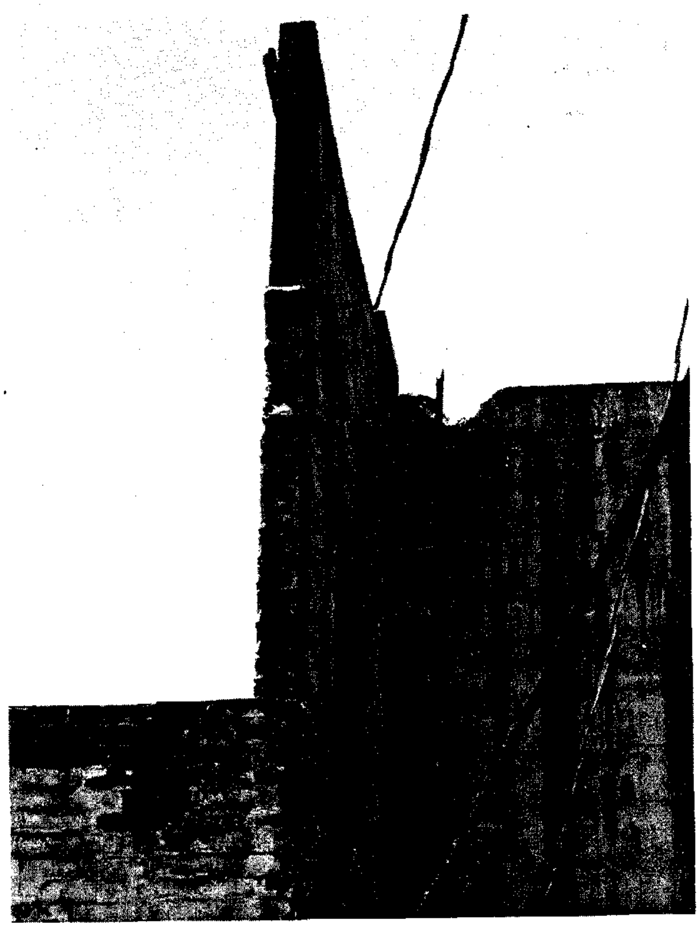


Fig. 17

Potential Hazard

Unsecured Appendages

Failing Facade Member

--Shown is a fractured member of a URM structure overhanging the public sidewalk

(Port Townsend)

Unsecured Cornice

--Shown is the separation between cornice and parapet wall. No tying is found between the two

(Port Townsend)

Failing Cornice

--In this example a deteriorated cornice is shown. It is separating from the parapet wall

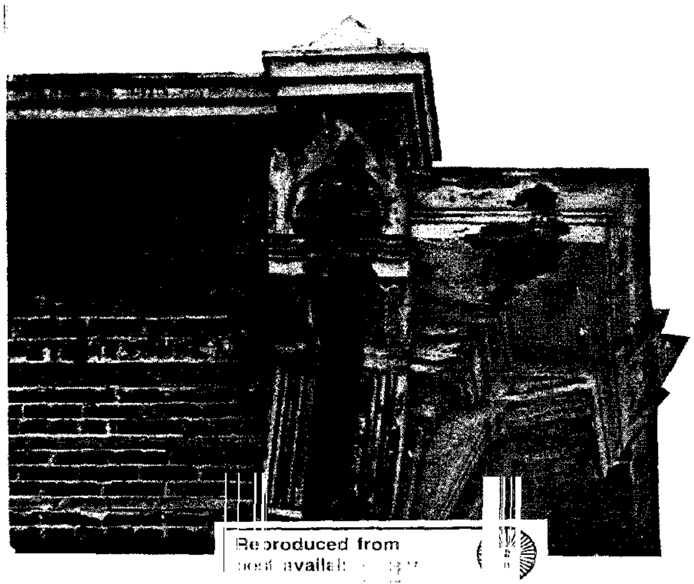


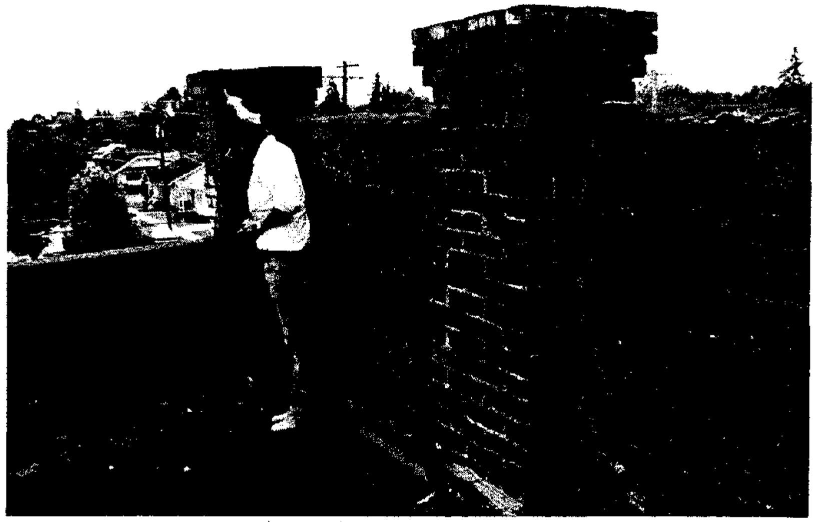
Fig.18

Potential Hazard

Parapets & Chimneys

Untied Parapet

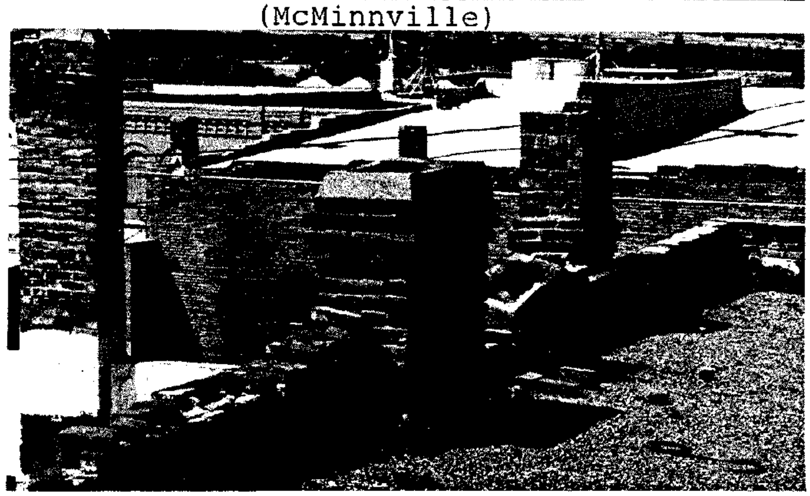
--Deteriorated mortar in parapet wall. Six ft. high above roof and extending four feet below to ceiling joists



(McMinnville)

Crumbling Parapets

--Parapets and chimneys with loose and dislodged bricks



(Ellensburg)

Loose Brick

--Extensive erosion of mortar joints with loose and missing brick

Fig. 19

(Ellensburg)

Potential Hazard

Foundation

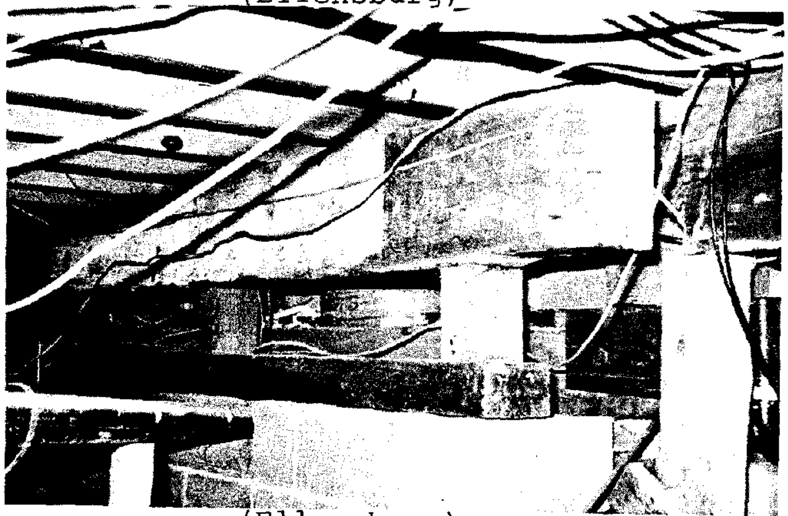
Structural Timber Rot

--An example of rot of structural timber due to the presence of water and the lack of ventil- ation. House jacks suppor rotted joists and beams

(Ellensburg)

Discontinuity

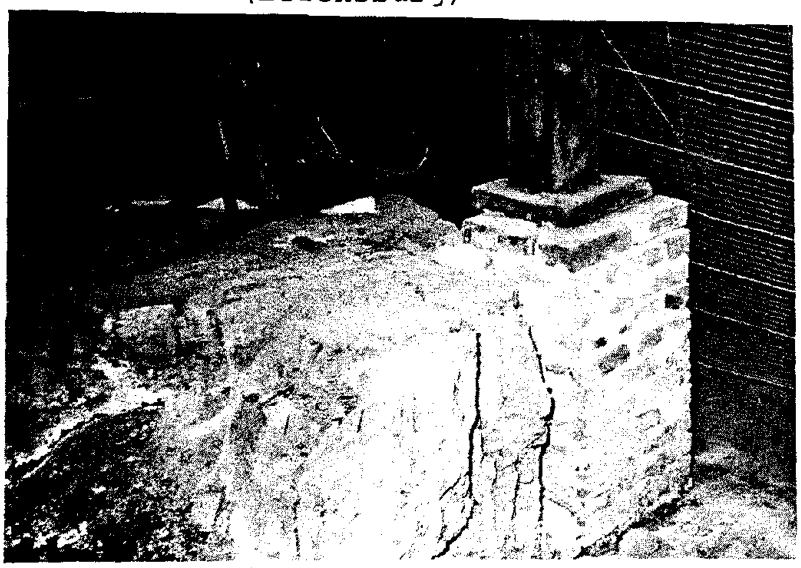
--Discontinuity of beams in new construction.No lateral reinforcement



(Ellensburg)

URM Pilaster

--Shown is an unrein- forced masonry pi- laster supporting load bearing column



(Oakland)

Fig. 20

Potential Hazard

Deteriorated Brick And Mortar in URM Walls

Fracturing

--Fracturing shown due to settlement of an URM wall

(Ellensburg)

Erosion of Mortar

--Shown is a typical case of erosion of mortar joints in an URM wall. In some cases mortar could be scraped away with a fingernail

(Port Townsend)

Spalling of Brick

--Advanced deterioration showing spalling brick, missing brick, and mortar erosion in a URM wall. In this example brick could be removed by hand

(Bellingham)

Fig. 21

In Port Townsend, Ellensberg, and Bellingham, the potential hazards existed in a large number of the URM buildings in the town. The case study buildings revealed extensive mortar erosion and fracturing of masonry in URM walls and appendages. Foundations in many cases were not reinforced to withstand lateral forces and consisted of rotting wood and brittle masonry. In some rehabilitation efforts lateral reinforcement was not a consideration in the strengthening of the foundation that had occurred. In almost all case study buildings no tying of URM walls, parapets, or other appendages was to the interior timber structure was observed.

In the Oregon towns of McMinnville, Jacksonville, and Oakland the probability is much less that a damaging earthquake will occur. However as noted previously, that probability does not rule out the possibility of local variation or new developments in the understanding of the seismology of the region that could change the assigned probability.

In Jacksonville and Oakland, Oregon, of great concern, in addition to the potential seismic hazards, was deterioration of the building elements and materials. A great number of the buildings exhibited extensive mortar erosion, wood decay at the foundation level, and fracturing of masonry walls and building elements. Gravity loads were a potential hazard in some of the buildings examined. Lateral forces caused by wind, vibrations do to heavy traffic, or even a setting pigeon could dislodge the unsecured bricks in some of the buildings in those towns.

Some bricks in the case study buildings were so loose that they could be removed by hand and the mortar carved away from brick with light scraping of a knife. Evidence of fallen brick was observed in some of the towns and residents recalled recent brick that had fallen to the street.

D. Legal Issues and Consequences of Nonenforcement of Building Codes and the Lack of Maintenance in Unreinforced Masonry Buildings

There are several liability issues that could affect owners of buildings, either private or public, if an earthquake were to occur and injury was sustained by individuals during the event or if there was a partial or total collapse without an earthquake and injuries resulted.

Possible defendants in a negligence action include the architect, the developer, the contractor, the property owner and the public entity, city or county, involved in a building damaged and/or causing damage in an earthquake.

Negligence could be established if a duty existed and was not performed. For example, the owner of a building damaged by the crumbling of another recently renovated building could sue the architect of the crumbling building since the damage might be held to be reasonably foreseeable. The architect of a renovated building knows, or should have known, that certain engineering principles could be used to minimize or eliminate potential earthquake damage. If the architect fails to employ accepted engineering principles to minimize the hazards to life or property, then it can be argued that he has been negligent.

In legal terms, if there is a duty to maintain the condition of the building, then there is a "standard of conduct" to be performed." The duty for the owner is to exercise reasonable care with regard to any known dangerous condition and to maintain the premises in a reasonably safe condition.

If the legal duty to maintain a building is established and the building is allowed to become hazardous because of deterioration, an individual injured by a crumbling building still must prove his injury was related to the lack of action by the owner or agent of the owner.

In many of the towns the team visited, the loose bricks and potential hazards were time bombs for public or private owners. There is clearly a duty to protect people in unreinforced masonry buildings and people on the street; that duty extends to inspection and maintenance as well.

For public entities, the question is this: Can public entities be held liable for injuries or losses in an earthquake by their failure to eliminate hazards that they know of or should have known of? The answer is yes. Again, it is the issue of duty. There is a public duty doctrine under Washington State law that previous cases have established.

--A duty exists if a government agent is under statutory obligation to abate a specific known and dangerous condition but fails to do so.

--A duty exists if a government agent fails to abate a known hazard.

The approach in the past for these hazardous buildings has been that unless the local agency establishes some sort of special relationship with the private owner, the city government and its inspection departments will not be liable for the injury sustained by an individual from a crumbling building because a duty by a local agency to abate the hazard was not performed.

Many Town governments have had a "hands-off" policy because they believe they will be less liable. Contrary to this, courts have found that a relationship can exist between an injured party and a public entity that establishes a public duty to remove known hazards from private buildings.

The legal issues arising from the potential hazards of unreinforced masonry buildings were researched in detail by Patrick McGreevy, land use attorney. His detailed analysis is included in the Appendix.

III. The Case Study Towns: History, Economics, and the Enforcement of Codes in Unreinforced Masonry Buildings

PORT TOWNSEND

History

Port Townsend appears to have everything: a beautiful setting along the far northwestern shores of Puget Sound;a temperate climate; a fascinating history; significant Victorian architecture; and a large collection of unreinforced masonry buildings.

In 1851 Port Townsend's first land claim arrived in the territorial land office in Olympia, beating Seattle by six months.The early pioneers were optomistic about the future of their village, even though in the early years Port Townsend's main source of income consisted of felling the great trees along the water's edge and towing them out to passing ships headed for San Francisco.

What fueled the great expectations for Port Townsend in the early 80's and 90's was the same mania that gripped countless other small towns in the West--a confident hope that they would not be overlooked by the railroads. But politics played a primary role in the decision of track location and Port Townsend lost its bid to more powerful communities.

Port Townsend was originally laid out in a grandiose scale to house the population that would arrive with the railroad. The commercial buildings on the main street were built for a population of 20,000 but when the railroad line went to Seattle the buildings were never fully utilized and the population never grew dramatically. In 1889 the population was close to 7,000 and with mild fluctuations it has remained so for almost 100 years.

Economy. Though population growth in Port Townsend has been minimal recent growth in retail activity has been more substantial. During the period between 1970 and 1982 retail sales tripled reflecting the town's strength as a retail/service center for Jefferson County and the increase in tourist activity. The increase in retail activity was related in part to the rehabilitation efforts that were occurring in the late 1960's and early 1970's . Though it is easy to exaggerate the affect of the early preservation activities on the economy of Port Townsend the town did experience a renaissance that transformed a significant portion of both the architecture of the community and its economic base. Popularity with tourists and the rehabilitation of the historic masonry buildings in the downtown core has had a positive affect on occupancy rates. In 1960 some60% of the ground floor space in the rehabilitated buildings was occupied. In 1984 the occupancy rate was 95%. The uses in these buildings in 1960 was split between retail and professional but today the uses are primarily retail. Though the ground floors are in use a large percentage of the buildings still have upper floors that are unoccupied.

In comparison to Seattle's Pioneer Square, where fully serviced retail space runs between $12-18 per square foot, in Port Townsend similar space will lease for as little as $3.50 per sqft to a maximum of $4.50 per sqft. With this amount of rent revenue available an owner does not have the ability to carry out extensive rehabilitation.[1]

<u>Administration of Building Codes</u>. The town council and mayor have pursued a policy of leniency when it comes to applying building and fire codes in the town's historic buildings. Though they have regularly adopted every addition to the Uniform Building Code, they do not require permits or inspections in the historic core where the 1889 buildings were built nor does the local fire department review plans.[2]

The previous building official who instituted this lenient enforcement policy described the policy as a way to encourage people to invest in the restoration of victorian buildings, particularly those downtown. Because of the economic benefits of attracting tourists to Port Townsend and the limited financial resources of some owners the city has adopted a nonenforcement policy to facilitate the use of historic buildings in the downtown.[3]

It has been stated by the State Fire Marshall and it has been one of the findings of this study that in small towns the technical knowledge is not available to enforce components of the code in the older unreinforced buildings. Adequate code enforcement has not been occurring and that towns employ what the Fire Marshall calls the Mitchell Dumont Theory (Dumont being the district attorny in Skamania County): "If the town just ignores the code situation, they will be <u>less</u> liable than if they did something and it proved to be inadequate after the event. This theory to put it succintly is a crock."[4]

Even though in the short run the City of Port Townsend may indeed encourage the utilization of some of their unreinforced masonry buildings by not enforcing the code, in the long run the buildings may not survive. Because of the innappropriate rehabilitation that has occurred many potential hazards remained unchecked or have even been increased as a result of that lack of attention to maintenance.

Port Townsend and Earthquakes. Port Townsend is situated in the Puget Sound where it will experience earthquakes in the future like it has in the past. Though local residents in town cannot remember significant damage from the 1949 or 1965 earthquakes, the history of earthquakes over the last 114 years identifies earthquakes that have been felt in the community. The most damaging earthquakes of 7. -7.5 on the Richter scale occur infrequently, but an earthquake of mercalli intensity V111 or 1X appears to be probable anywhere in the Puget Sound Basin at about one a century.

The seismic code risk map of the Uniform Building Code places Port Townsend in a zone 3 and it is mapped as an Effective Peak Acelleration zone of .20 in ATC3-06. A 3 hazard rating means that damage could take place because of an earthquake corresponding to a Modified Mercalli Scale of VIII or higher. An earthquake with and accelleration of .20 would affect most directly the unreinforced attachments and unreinforced walls of buildings. It is also known that some of the historic buildings of Port Townsend are located on fill material and are therefore likely to experience even greater seismic effects than those described above in the event of a major quake.

2. McMinnville

History. McMinnville has the qualities one might associate with Norman Rockwell's vision of "small town America". Nestled in the central portion of the Willamette Valley McMinnville has the intimacy and agricultural past so common to the small town. But it is a town looking at change as well for the industry of the past like lumber and farming can not support the population of the 1980's. Instead,new employment is forming, around the emerging wine and tourism industry that has grown along the Pacific Highway. McMinnville is also starting to attract hi-tech industries that wish to operate in the Portland vicinity.

McMinnville's history began during the mid-1800's, when like many villages in the Pacific Northwest, pioneer families filtered into Yamhill County, building small cabins, and beginning new lives. The early claim of W.T. Newby in the 1850's marked the official birth of McMinnville.

By 1856, the town's surveying and platting plans were complete. The plat gave the streets a 60 foot width, and the lots 60 by 100 foot dimensions. By 1866, the Federal Register recorded 300 residents living in McMinnville, in addition to "numerous stores, and tradesmen occupying its streets." All the elements of a small city had taken shape, despite the fact that it was not to be incorporated until 1882.

1882 marks the year of McMinnville's incorporation and its adoption of the first charter. The years between the formal incorporation and 1910 were busy ones for McMinnville. Most of the downtown mainstreet historic unreinforced brick buildings were built during this period.

The 1970's saw typical small town economic "peaks and valleys", as recession and boom periods followed by longer and deeper recessions changed the economic character of the town.Today in the 1980's the town is still recovering from the recession that impacted the state of Oregon in 1983 and 1984, and caused a depression in the once stable lumber industry.

Economy The growth of McMinnville's economy began making headway in the middle of the nineteenth century. During the more than 95 years since McMinnville was first incorporated, it has grown from a settlement of 600 to a city of over 14,000. The city has experienced continuous population growth since 1876. The population increased 40% between 1950&1980.

Employment opportunities, of course, played an important role in bringing settlers to town. Because McMinnville's natural resources were in particular demand in the nineteenth and early part of the twentieth centuries, the city's history is tied to agriculture and lumbering.

Agriculture and timber industries were in full swing until 1940, when they began to take their toll on the land. In 1950, soil erosion brought agricultural growth to a standstill, while the lumber trade experienced poor harvests. The once active Nestle sweet milk condensary was closed in 1953, McMinnville's only recorded population drop occurred in this decade.

Today the economic base is broader than it once was. Cascade Steel Rolling Mills, Inc. employs 400. The Oregon Mutual Insurance Company employs 375. These two major employers are followed as job providers by Skyline Mobile Homes, Hewlett Packard, Mrs. Smith's Foods, Archway Cookies, and other food and grain companies.

With half the population of McMinnville in their working years, the service industry and public sector must pick up a major share of the employment burden. The 1980 census indicated that unemployment was running at 8.3% of the total work force. In a state that was running at high levels of unemployment during the 1980 recession this rate is considerable less than other small towns. Some owners of buildings would have you believe that the situation has not improved dramatically and that unemployment is quite high, even as the economy bounces back in other towns and cities in the state.

One problem for the economic stability of the downtown is the growth of business on the fringe of the town and the increased activity along highway 99. As chain stores with high volume and cheaper prices move into the region, the small stores in the historic core that cannot offer similar prices or volume could be affected. This is a concern many owners have voiced.

Conversely, there are several stores that offer both service and competitive prices that have not only survived but are doing quite well. This indicates that though the downtown might not be a healthy location for all businesses, it can be profitable for entrepreneurs who are able to determine a market and create a service or product that sells.

Administration of Building Codes. The process of code enforcement of historic buildings has not been tested often in McMinnville because there has not been major rehabilitation in the historic core. The work has been piecemeal, with little or no structural change to the buildings, or dramatic change in use.

Larger rehabilitation projects would require plan review and permit issuance as would new construction. Any code interpretation or granting of leniency would be made by the building official.

The philosophy that is espoused by the department is that fire and life safety cannot be violated for public assembly and there is no leniency in these matters. How the building official would handle a major rehabilitation is unknown. If the building could not meet code without major expense or without major structural renovation, would leniency be granted?

Rehabilitation work over 4,000 square feet or 20 feet in height must be "engineered". This is a code requirement the building official was very adamant about, with a philosophy that any major work will require the assistance of a structural engineer with plans submitted for review. It is also state law that any building has to have a permit issued for anything outside of maintenance. "We go by the book, we issue all permits."[1]

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The Apppeal Process for Historic Buildings. There are no national register historic buildings located in the historic core of McMinnville, though the planning staff recently prepared a survey of historic resources as the first step in creating an historic district in McMinnville.

The unreinforced brick buildings would be treated with no special consideration until they became historically designated. The building official would then have the option to submit plans to a special state committee. The committee could grant a variance from the state building code providing relief to an owner rehabilitatiing an historic building. The Code Chapter 4903 of the State Building Code reads as follows:

a) Historic Building Review Committee

In order to determine to what extent historical buildings must be made to comply with the requirements of this code,, without destroying the qualities which necessitate its preservation, there is herewith established a statewide Oregon Historical Building Review Committee. This committee is charged with the responsibility of granting variances for the preservation of designated historical buildings but is not empowered to grant waivers per se, in that the code compliance is one means of preservation.

b) The review committee shall consist of the director of the Department of Commerce or the director's representative, the building official or local representative of the municipality in which the historical building is to be reviewed for preservation, and the State of Oregon historic preservation officer.

c) The review committee shall have the power to waive any provision of the state building code when in its opinion such historic buildings are not hazardous to life or health and the proposed variance does not conflict with the public interest.

The code goes on to require stamped plans from a state structural engineer declaring that the historic building will not be hazardous to the public. It is interesting to note that the committee's actions must be approved by the Structural Codes Advisory Board, insuring that any preservation action taken by the committee would not affect the integrity of the structure or endanger the public's safety.[2]

The only instance where judgment by the local building official might come into play involves the question of what is considered maintenance and what is considered rehabilitation. The building official in this case must decide whether the work is necessary for the prevention of deterioration or whether it is an alteration of the structure. Ordinary maintenance would not require a permit.

The owners of buildings the research team talked with did not indicate that they had conflicts with the buildings official over enforcement policies. The owners did not carry out major rehabilitation and only performed minor alterations and maintenance work and in most cases did not change the use or occupancy of the structure. Therefore, they caused few enforcement incidents with the city and were not required to bring the entire building up to code. This policy is exactly in line with the UBC Section 104 applied to existing buildings and structures. "Additions, alterations, or repairs may be made to any building or structure without requiring the existing building or structure to comply with all the requirements of this code provided the addition, alteration, or repair conforms to that required for a new building or structure." (2) In McMinnville major rehabilitation did not occur and buildings were not required to be brought up to code.

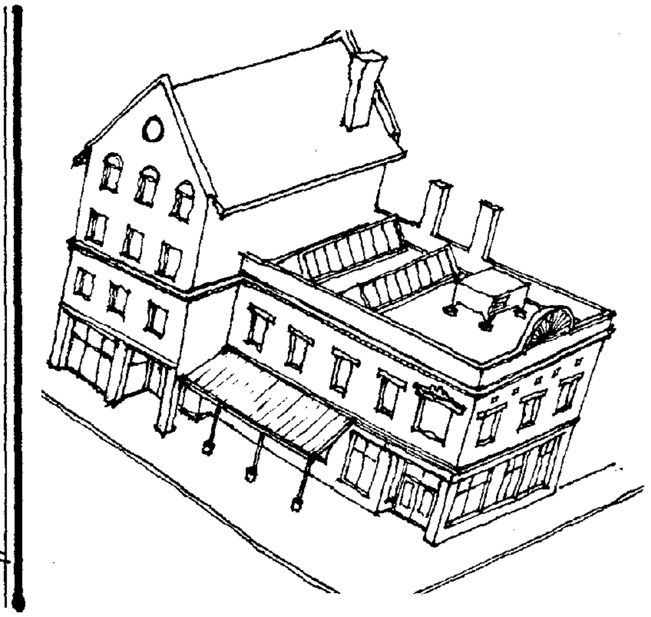
Seismic Conditions in the McMinnville Region. Past Events. The Mercalli scale observations of earthquakes as described by the State Department of Geology and Mines in 1950, before seismograph stations were established, show a distribution of earthquakes with greater frequency in northwest Oregon and the Portland area, the northeast around Pendleton, and the southeast near Klamath Falls. None of the reported earthquakes prior to 1950 exceeded VIII. An Intensity VIII event has occurred only once in 1877 and intensity VII events have appeared twice.[3]

Earthquake Probability. Oregon can be divided into several physiographic divisions. McMinnville would be located within the Williamette Valley. Earthquakes historically have been located north of McMinnville in the Portland area, and McMinnville itself would have experienced effects only of distant earthquakes. The energy released from earthquakes in the past is a means to approximate the magnitude of future earthquakes. The level of activity between 1870 and 1970 suggests that the Williamette Valley would experience a 5.3 (intensity VI) quake every 30 years. Where the epicenter would be located and its affect on McMinnville would be more difficult to predict.

In conversation with residents in town, very few remembered any earthquake activity and of the earthquakes that were remembered, none caused any damage. The greatest threat to McMinnville could be from distant earthquakes. In 1949, the magnitude 7.1 earthquake in Washington caused intensities of VII throughout the Portland area. The McMinnville area may experience an earthquake with intensity VI every 30 years. In comparison, California would experience 30 such earthquakes during a similar time frame

3. Vancouver

History. Vancouver is the largest of the towns studied by the research team with a population of a little less than 50,000. It is one of the oldest settled communities in the Pacific Northwest and it was here on the northern side of the Columbia River that the Hudson Bay Company set up its company store and from here it set out its explorers and traders between the 1820's and 1840's.



Typical case

Vancouver has a small historic commercial core where the majority of 19th century unreinforced brick buildings are found. Those buildings seldom reach more than two stories above the ground floor. In many of the buildings cardrooms occupy the ground floor with vacant space above, but this historic district is changing, and the beginnings of a rehabilitation effort is taking shape.

Vancouver is the oldest, continuously inhabited settlement in Washington State, and yet its early history reveals the reasons for its relatively small size. According to the West Shore newspaper, 1833, Vancouver was ignored as a potential metropolis because of the antagonistic sentiment felt for the British by the more abundant American settlers. As the first settlers to embark on Vancouver's shores, the Hudson's Bay Company founded Fort Vancouver for the purpose of developing the northwest fur trade. It was the most important settlement from Mexican California on the south to Russian Alaska on the north.

England lost interest in Vancouver in 1846 and the Hudson's Bay Company moved its western headquarters from Fort Vancouver to Vancouver Island. The Oregon Territory was established by Congress on August 14, 1848; and the first U.S. soldiers arrived in Vancouver about a year later. Long before Vancouver had been abandoned by the British, Portland had become the accepted metropolis, with the additional bonuses of its proximity to the Willamette Valley settlements and its deep water port.

The motor car era of the early 1900's gave a great boost to Vancouver and provided accessibility to the town that had been so long denied by a lack of rail and port facilities. After years of political maneuvering, construction of the First Interstate Bridge began on March 6, 1915. The new bridge and increased activity due to World War I brought new economy into the town.

Today, with help from the I-5 corridor,and despite the inherent competitive edge of Portland, Vancouver appears strong and greatly diversified. Over the last few recession years, the city has maintained a stronger rate of growth and a lower overall unemployment rate than either Portland or Seattle.

Economy. Vancouver, at one time, was isolated along the Columbia; economic development and population growth dictated by the river. As towns north and south like Seattle and Portland grew, Vancouver hovered around a population of 20,000 in the mid 1900's. Portland population soared and its suburbs spread. Vancouver's environment has changed, but not with the same sprawling growth. The main street of the old town is still the main street of the new one, and the commercial and office activity continues to focus along that spine, just as it did in the 1850's. Change has already begun and major construction projects totaling 800 million investment in the city and county have been completed or are underway.

The Port has played a major role in Vancouver's emergence as an economic center in the state of Washington. As quoted from Money magazine in its survey of Vancouver, "Asia's new importance as a U.S. trading partner has had a dramatic effect on Northwest ports. Vancouver's import-export business more than doubled from 1978-1980 and will double again by 1982." The Port has the capacity to handle increased volumes with over 650,000 square feet for storage of containers and a deep water channel on the Columbia of 40 feet.

Vancouver's non agricultural wage and salary employment grew 32% between 1975 and 1980, an increase of 12,860 new jobs. There are 226 major employers in Vancouver and Clark County including some of the nation's top 500 industrial corporations. Tektronix employs 2,000. Crown Zellerback employs another 2,000. There is Jantzen Knits, Frito Lay, Burlington Northern, and general brewing all major employers that are located within the city limits.

The effect of these industries on the entire Vancouver economy is substantial and the dollars would spread through the entire service and retail sectors creating greater demand for construction and the rehabilitation of buildings in the downtown core.

With this kind of optimistic economic environment, construction projects in Vancouver have been occurring with greater fervor than in the past. In March of 1983, the city's first major high-rise office building was built at a cost of 15 million dollars, the 10 story SeaFirst Financial Center is one block off of Main Street where the majority of unreinforced brick buildiings are located.

The city has been a partner in helping to encourage investment in the downtown. A $650,000 beautification program was recently launched for the South Main District where many unreinforced brick buildings have yet to be rehabilitated. The value that will be created at the street level with landscaping, sidewalk improvements, and signage and seating will encourage rehabilitation and encourage retailers to locate businesses in the historic core.

Administration of Building Codes. The city of Vancouver's building department has a cooperative relationship with building owners and their architects and engineers. The building official describes a permit process for the rehabilitation of older buildings that is by no means perfect, but working pretty well. "Being a good communicator is a big part of what I do," he explains. "It used to be easier to go to the dentist to get teeth pulled than to come in here for a permit." But a good working relationship has developed between the building department and those who are rehabilitating older buildings. Because of the differences found in each rehabilitation project, discussion is often needed in determining what gets done.[1]

The seismic provisions that have been employed in the more recent rehabilitations are the result of the dialogue between owner, architect, engineer, and the city. In recent rehabilitations the engineering firm responsible for the structural design was one of the most experienced firms in the Vancouver and Portland area. The engineering recommendations for seismic hazards as approved by the city established a standard that was not found in other small towns. The permit process for older unreinforced masonry buildings was a hand-in-hand process with the city and the owner; unlike other small towns that had no review process at all.

Philosophy Towards Historic Buildings. The building official understood the difficulty of rehabilitating URM structures to code and was quick to empathize "you can't make an old building meet codes." As a result of his understanding of the special nature of older buildings and the need for special judgment of codes as applied to them, he established a section in the Vancouver code relating to historic buildings. The section of the code 17.08.110 entitled Historic Buildings reads as follows:

> Repairs, alterations, and additions necessary for the preservation, restoration, rehabilitation or continued use of a building or structure may be made without conformance to all the requirements of this code, when authorized by the building official.

There were five provisions that were also included:

1) The building is listed in the Federal Register as historic or is listed in the city's list of historic buildings or has been designated by official action of the legislative body as having historical or architectural significance;

2) Any unsafe conditions will be corrected;

3) Any substandard conditions will be corrected in accordance with approved plans;

4) The restored building or structure will be less hazardous based on life and fire risk, than the existing condition; and

5) All work is to be designed by and supervised by an architect.[2]

The building department was not tenative in their approach to unsafe conditions in older buildings. In several instances they had condemned buildings for what they considered to be unsafe structural conditions. Often times, this strategy would force an owner to correct a dangerous appendage; in some instances the use of the building was terminated; and in other cases buildings were demolished. For these reasons, one does not find as many deteriorated and dangerous buildings with unsafe parapets and brick appendages as in other smaller towns.

The building department in Vancouver, as in many growing communities, often must make difficult decisions between public safety and economic development. From the department's perspective it is important to ensure that the rehabilitation of historic and older buildings is done in a proper and safe manner. On the other hand, they do not want to stifle the often precarious economic growth that may be occurring in the older and historic core.

Seismic Conditions in the Vancouver Region. Past Events. On November 5, 1962, an earthquake occurred just north of Portland and it was the largest shock to occur in Oregon since the seismic monitoring stations were establiished in the 1960's. A magnitude Richter scale 5 and a maximum ground acceleration of .16 g were recorded by the U.S. Coast and Geodesic Survey strong motion seismographs in Portland. The earthquake was noted in Portland where a ceiling light fixture fell to the floor in a city library and in other parts of Portland, masonry was cracked and some chimneys toppled. (3)

The most recent work done on the seismicity of the Vancouver region was completed by the State of Oregon's Department of Geology and Mineral Industries in September of 1981. They reported on the seismic hazards of the Mount St. Helens region in relationship to the Trojan Nuclear Plant just north of Vancouver.

They concluded in that study that the Mount St. Helens seismic zone exhibited shallow seismic activity with the possibility that one single fault existed, but that the area was not a major tectonic boundary and clearly within the North American plate and would exhibit generally fewer earthquakes than boundary related regions.

Earthquake Probability. The Oregon report determined from the available data that a 7.2 magnitude quake could occur however if if the Mount St. Helens seismic zone represented a single fault and if that fault ruptured along one half its length to yield the maximum possible quake, then such a quake will probably occur about once every 10,000 years. More reasonably, they concluded that an earthquake in the range of 5.2 once every 100 years and 6.2 once every 1,000 years appeared more likely.[4]

4. Ellensburg

History

Ellensburg is the largest town in Kittitas County.It is located in the center of Washington State and at the foot of the eastern side of the Cascade Range. It is a town with a population of 11,000 that has undergone a tripling since the 1890's. Historically the town has been tied economically to the agriculture and timber resources of the region as well as the production of non-dairy cattle. More recently Central Washington University has played a major role in the economic health of the town.

URM Facade

Settlement of the area began in the 1860's when Ellensburg was only a trading post known as Robbers Roost. In 1873 the first acreage of the townsite was surveyed and 80 acres laid out by early settler John Shandy, who registered the name of the town Ellensburg in 1875 after his wife Mary Ellen. By 1880 the town had a typical collection of wood frame hotels saloons and mercantile establishment.

The population grew dramatically in the first few years, like many new settlements,and doubled its population in 1888. Much of the increase was credited to the location of the Northern Pacific Railroad terminal in Ellensburg in 1886. The railroad brought Ellensburg in touch with new markets and insured economic stability for the future.

In 1889 catastrophe struck Ellensburg, as fire destroyed the 10 block collection of wood frame buildings of the 10 year old settlement. Immediately after the fire of July 4, 1889, the familiar brick buildings of today were built. Almost overnight carpenters, brickmakers, and bricklayers rebuilt the entire town. Seven different local brick yards supplied what is called today the "Ellensburg soft" brick for the construction of 75 new buildings. The intensity to rebuild as quickly as possible was brought about because of the competition for the state capitol and the speculation in real estate that was occurring in Ellensburg at that time.

Economy.Ellensburg has experienced what other towns in our study have experienced, the loss or reduction of the traditional industries that were established in the early years and provided an income for the town's population.

Today Ellensburg has only one major industry, related to the towns agricultural past: Twin City Foods Processing Company. The 1980 census indicates that only 128 individuals of a labor force of 4,600 were employed in the traditional industries of agriculture, forestry, fisheries, and mining. The majority of the labor force is associated with retail trade and service. Central Washington University is now the biggest factor in the economy of the town. One half of the population of the town is related directly to the on campus University population, and it is no surprise that the University drives the economy.

In recent years, Ellensburg has been promoting itself as the tourist center of Kittitas County with the annual rodeo that attracts 10,000 as the biggest event.

The promotion of the historic character of the masonry buildings has been an element in the tourist campaign. In the 1970's a National Register District was formed around the 1889 brick commercial buildings of the downtown and an effort was made to convince owners to fix up their buildings and make use of the ground level storefronts.

A historic preservation ordinance was established in 1981 by the Downtown Task Force that provided a system of review and advice for owners whenever exterior work was being undertaken on the URM buildings. The recommendations by the task force were only advisory but the purpose was to ensure that the turn of the century architecture would be maintained as an economic, promotable asset.

One element for ensuring that retail spending was funnelled to the downtown was a council policy preventing the arterial strip developments and large malls from locating in town. That council policy helped to insure that retail spending remained in the historic core.

This preservation campaign by the mayor and the Downtown Task Force,combined with public sidewalk improvements, has encouraged rehabilitation in the historic core and helped to maintain low vacancy rates in the ground level storefronts. High vacancy rates can, however, be found in the upper floors of many of the URM structures. This was the situation in every study town. Ground floor space was marketable, the upper floors which would require significant capital expenditures, were not because a market for their use was difficult to define.

Administration of Building Codes. The city Building Department enforces building code at the local level, reviewing plans and issuing certificates of occupancy on rehabilitation work.

The 1982 addition of the Uniform Building Code was adopted by the building department and enforced by a newly appointed building official.

The new building official was immediately embroiled in controversy over an issue involving the rehabilitation of the historic URM buildings. He insisted that two architecturally significant castiron columns be covered to achieve two hour fire rating. This went directly against the wishes of the mayor, the Downtown Task Force, and the owner of the building. As the enforcer of the Code, he would not waive this requirement for he could become liable for the decision he made.

This example is in contrast to other study towns like Port Townsend where building officials followed the political wishes of the community even in matters of life safety in the URM structures.

Owners of buildings in town described a concern that Ellensburg's building department was too conservative on its code enforcement. The policy the department has followed in the past concerning the rehabilitation of existing URM buildings was that the building be safer after rehabilitation than it was before. Plans are required and reviewed by the department and a certificate of occupancy issued.

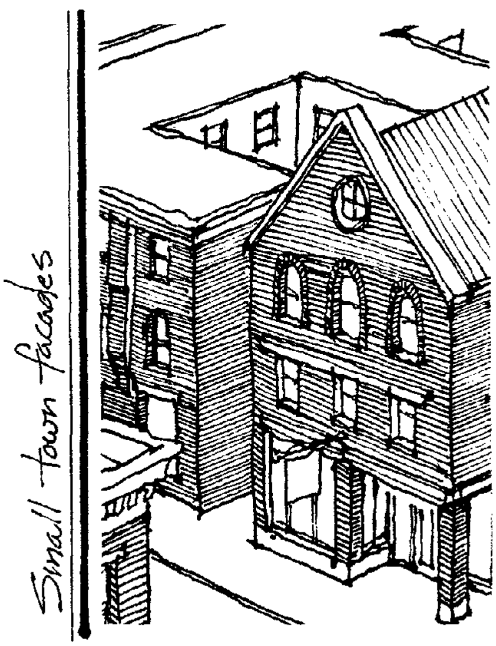
To date no seismic requirements have been enforced in rehabilitations by the department and the recent building official admits that he does not have the knowledge in this aspect of code enforcement. This was typical in each of the study towns when a building official did not have the technical knowledge to address seismic design. The department did not have a policy of inspecting buildings for potential hazards and the study team found from our survey that potential appendage hazards of loose brick in chimneys and parapets existed that had not been abated by the department.

Seismic Conditions in the Ellensburg Region. Ellensburg has experienced earthquakes in the past as identified in the Bulletin of the Seismlogical Society of America. After the earthquake of 1949 seismographs were established to provide a more accurate estimate of earthquake intensities. A quake in 1872 felt by communities between Eugene ,Oregon and British Columbia of intensity VIII+ was felt strongly in the Wenatchee/Chelan area and affected Ellensburg significantly, but in general earthquakes in eastern Washington are shallower with a magnitude lesser than western Washington. Between 1865 and 1951 earthquakes of intensity 111, 1V, and V were reported occurring in Ellensburg.

Some longtime residents do recall earthquakes occurring in town in the Mid 1930's, with an intensity that was enough to affect walking across the room.

5. Bellingham

History. The first to discover Bellingham Bay was British explorer, Captain George Vancouver, who sailed into the bay in 1792. The British fur traders of the Hudson Bay Company followed in the 1830's to share the Bellingham Bay shores with the Lummi Indian tribe. Not until the 1850's did the first settlers arrive to exploit the resources of timber and coal.



In 1858 there were three different communities forming along the bay. Fairhaven, Sehome, and Whatcom. The towns were rivals for the resources of the bay until 1903 when it was agreed to consolidate all of the communities under the name of Bellingham.

In the 1880's and 1890's the timber and fishing industries on the bay were strong, and eight major sawmills and shingle mills and four salmon packing facilities operated in the growing little communities. A sizable business district developed in Fairhaven in the speculative boom of the late 1880's and many masonry buildings were constructed before the consolidation of 1904 had occurred.

Over the last 30 years business and industry has shifted to central Bellingham away from the southern end of the bay; Fairhaven lost population and the economic vitality it once enjoyed. Old Fairhaven has the largest collection of brick buildings that recall the economic boom of the 1880's and in an effort to preserve the old town it was designated as a National Register District in 1977.

The towns along Bellingham Bay courted the railroads and by 1902 three major railroads had lines extended to Bellingham. But it was clear Seattle would become the important railhead port on Puget Sound and the population and port economy leveled out.

Economy. The economy of Bellingham has seen its boom periods but more recently it has experienced economic hardship and an unemployment rate of 10-12%, in a time when other towns have recovered from the most recent recession. Fishing and logging are down in terms of jobs and sales in the county are down from what they once were. The port has not developed in the way planners had hoped.

The economy is not expanding and housing starts and population have stabalized. Over the last 80 years, population grew only by 11,000. Today it is close to 45,000.

In the 1970's the town was booming from the large number of Canadian shoppers. The retail sector of the economy was strong with 30% of the trade attributed to the Canadian spending. But retail revenues have not been increasing because of exchange rate has become considerably less favorable for Canadians.

Bellingham has been described as a place "to get away from not away to" and there has been a desire by businessmen to bring more tourists to town but as the town paper lamented in a recent editorial, there is no reason for a traveler on Interstate 5 to stop.

Old Fairhaven was once considered a destination for tourists but after several rehabilitation efforts failed, the historic district has returned to a familiar state of abandonment.

One of the most important economic resources has become Western

Washington University. The University has provided a significant number of service sector jobs for the community. The economic climate is not joyfully described by residents, and planners have been looking for ways of assisting the existing retail businesses which have become the heart and soul of the economy. It is hoped the Expo of 1986,planned in Vancouver,will help the Bellingham economy and once again boost the economy with tourisit dollars.

Enforcement of Codes. The city of Bellingham will take over the administration of the building codes from the county in 1985.

The policy at the county level has been based on the philosophy that it is not possible to retrofit the existing unreinforced masonry buildings to 100% of the UBC,and that realistically the use of the building and the circumstances of rehabilitation will determine the code requirements.

In the existing URM buildings there has been no retrofit requirement if new uses are not introduced or substantial changes in use are not intended.

In Bellingham with the economy the way it is, it is not cost effective to retrofit the URM buildings to code. The building official identified an important ingredient of the code enforcement process--the degree of risk the community is willing to assume must be clarified before code action is instituted. He described his job as carrying out the policies as dictated to him. Even though the official recognized that potential hazards existed in many URM buildings he would not pursue an abatement policy without a clear policy from city hall, "You just can't knock down a heritage."[1]

Seismic Conditions in the Bellingham Region. Bellingham is located in the northwesternmost corner of the Puget Sound and has not experienced the earthquake activity of the Seattle and Olympia area further south. In the period between 1865-1951 earthquakes shook Bellingham with an intensity between III and V, with an earthquake of VII occurring just north in Vancouver in 1946. In the 1949 earthquake of Seattle that caused significant damage in the Puget Sound region the observed intensity in Bellingham was VI.

6. Oakland

History. Oakland is located in a small valley of Oaks known as the Umpqua in Southern Oregon. It is approximately an hour or so from the California border and is located three miles east of the I-5 corridor. The first settlers arrived in the valley in the late 1840's and were forced because of winter to stop temporarily in Oakland. A site north of the existing main street of Oakland was selected and the first cabins of the county were built along the Calapooya river. A grist mill and store were soon established and Oakland became the trading center for the surrounding area, and for the settlers who passed through on their northern trek to the Willamette Valley. Oakland was selected as a Wells Fargo stage stop in the 1860's and mail arrived once a week to be distributed to the many small towns in the vicinity.

The town was obviously interested in the railroad that was making its way north in the 1860's, and with local urging and the donation of land for the right of way, the line was located just south of the original townsite. The economic impact of the railroad was evident in this town like every other, and to take advantage of the economy the line could generate,the town founders moved the original structures off their foundation to the new southern townsite.

In 1878, the town was incorporated, at a time when it was recognized as a major shipping center between Portland and San Francisco. In the 1880's and 1890's, several fires struck Oakland destroying many of the early wood frame buildings. They were immediately rebuilt with brick from a local brick maker. Nearly all of the unreinforced masonry buildings on the main street were built around 1890.

Today the old main street depends on a different means of transportation for its economic survival. The I-5 corridor brings tourist dollars to the town and as other traditional industries faded,the old town image has become a marketable product. In 1979 the mainstreet and several city blocks were listed on the National Register of Historic Places, helping to promote the businesses of Oakland that were located in URM buildings.

Economy. Oakland reached its peak of economic growth and development by the mid 1880's when the railroad shipping brought prosperity to the town. The population stabilized and today the population of 900 is only 200 more than it was one hundred years ago.

Just as the cycle of the state and national economy reached peaks and valley, Oakland experienced different periods of boom and bust. In the 1920's and until the late 30's,Oakland was a center of turkey farming. The turkeys were raised like range cattle foraging in the hills around town and herded to slaughter with dogs. But the midwest developed a cheaper and more efficient industry and the Oakland industry could not compete.

In the 1940's,in the post war era,lumbering became a driving force in the economy for almost 20 years. But in the 60's with the loss of the local mill this sector of the economy had a lesser impact.

In the 1980 census,, Oakland had a labor force of 255 persons of which only 14 were employed in the forest industry. 85% of the labor force commuted to jobs outside the town indicating the reliance of Oakland residents on the economy of the county.

All owners, except one, of the commercial brick buildings in town, either had jobs outside of town or had businesses that were dependent on non-residents or tourists.

A recent victory was won by the town with the state highway department over the location of a sign on I-5 identifying Oakland as an historic district. This signage has helped to promote the historic commercial buildings to passing tourists.

Oakland, much like Jacksonville 90 miles south, can no longer depend on its traditional economic industries. The economic support of the population and the businesses that are located in the collection of unreinforced masonry buildings must come from a new source. Tourists provide a new market to help boost the local economy.

Code Enforcement and Administration. The building code is implemented at the Douglas County level, however because major rehabilitation has not occurred in Oakland the policy towards the unreinforced masonry buildings has not been clearly defined. Most of the rehabiliation had taken place over many years and was often nothing more than cosmetic alteration. Therefore seismic provisions had never been enforced by the building department.

The most interesting recent care concerning the interpretation of the building code for seismic elements involved the town's own rehabilitation of an unreinforced masonry school building for library and community space. The 1900's school building was to be demolished by the school district but to save the structure, an arrangement between the city and the school district was made.

A local engineering firm was commissioned to complete a study on the condition of the building. As described by the local historian who was involved with the rehabilitation, an earthquake that occurred in the Oakland vicinity made the consultant more cognizant of seismic design to the point where he recommended that maybe the project should not be undertaken.

Because of the lack of local knowledge on seismic design in URM structures outside technical advice was sought. The research team of ABK associates in Pasadena were contacted during the controversy that insued in this phase of rehabilitation.

ABK recommended that because Oakland was located in an EPA hazard zone of only .05 buckling of URM walls between anchorage points was improbable, and that the most cost effective approach was the anchorage of the exterior walls to the roof and floor framing. This recommendation was made based on their research into the damage of URM buildings during large distant earthquakes. They categorized the likely damage as:

1. Collapse of URM parapets extending above the roof level.

2. Separation of URM walls from the roof framing.

3. Collapse of the parapet and the portion of wall between the roof and ceiling of the uppermost floor.[1]

The town has proceeded with its rehabilitation plans with this cost effective compromise established as to the appropriate level of seismic reinforcement.

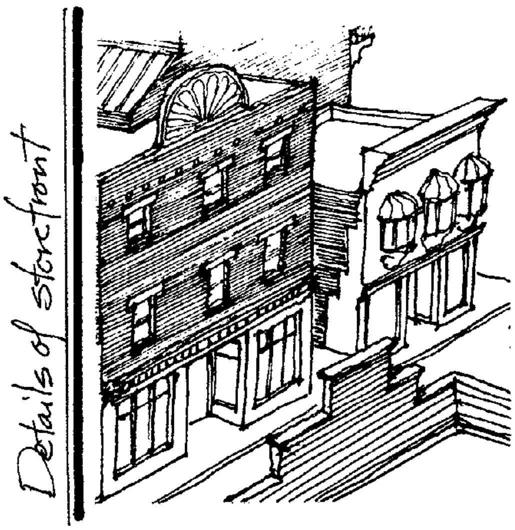
Other buildings in town had observable potential hazards that had not been addressed by the building department including parapet, chimmney, and appendage hazards,in some cases there were loose bricks above the right of way.

Seismic Conditions in the Oakland Region. Although records have been kept on earthquakes in Oregon since 1841 accurate recording of seismic events have been possible only since sesimograph stations were established in the Pacific Northwest in the 1960's. Estimates of earthquake intensities were established prior to seismographs by the observation and recording of felt effects.

Oakland which is located in the Klamath Mountain region has not experienced significant earthquakes in the 140 year period of record keeping. The only significant earthquake reported in the region occurred near Port Orford in 1873 on the coast west of Oakland.That quake had an intensity of Vlll. Only two other shocks were reported between 1841 and 1958 that were in the Oakland vicinity, both of which were estimated with intensities below V.

Longtime residents of Oakland could not remember any earthquake activity in their lifetime that had occurred in the town of Oakland. The town historian did not believe any earthquake of damaging consequence had occurred in the town's past.

7. Jacksonville



__History__.Jacksonville was born out of the goldfrenzy of the 1850's when prospectors flocked to the Rogue River Valley after gold was discovered on the Rich Gulch Stream. Then the town was described as being nothing more then tents and the log cabins of miners strung out over a fivemile radius. In 1853 the town was given its name and the little gold rush town grew to 1500. Jacksonville was the largest town in Southern Oregon for the many years before the turn of the century and was recognized as the Jackson County seat, serving as the agricultural and commercial center for miners and farmers in the valley. The majority of brick buildings that are still standing today were constructed in the 1880's after fire leveled the original structures of the mining community.

But Jacksonville like other small towns at tht turn of the century had its growth and prosperity stimied by decisions of the railroad companies and when Medford only a few miles away was selected as the railroad stop the decline of Jacksonville was imminent. The twentieth century brought with it economic isolation for Jacksonville as other towns in the Valley were better situated for the expanding agriculture and lumber industry. Gold became more difficult to find and the town could no longer depend on the economy associated with mining that had brought prosperity to mainstreet in the 1850's. The brick buildings once symbols of wealth entered a period when their use was uncertain. In 1927 the deathblow came when the county seat was moved to Medford.

In the depression years Jacksonville struggled along like most communities with a different twist: backyard mining became popular as residents returned to the early pastime as a means of income. Shafts were dug into the bedrock below properties extending in some places beyond their property to the mainstreet and beneath the foundations of the commercial buildings.

Preservation of the old mining buildings was favored by and fought for,by the longtime residents even as the condition of the buildings deteriorated. After a Model Cities program and Highway Plan were turned back in the 1960's the idea of preserving the one time gold rush community became generally accepted throughout the community. In 1966 Jacksonville was designated a National Historic Landmark District almost 10 years before preservation became popular in towns across the country. A new economic resource was found in the old brick buildings and tourism insured some longevity for them.

Economy. The poverty of the town through the 1950's had one benefit--it was a friend to preservation. Economic revitalization never occurred in Jacksonville and as a result the town is much what it was in the 1880's and 90's when the unreinforced masonry building were built.

The economy of Jacksonville is influenced by the proximity of Medford and the majority of Jacksonville residents commute to work in Medford. There is no industry or job provider other than service or retail employers in Jacksonville. The owners of shops on the main street depend on the tourist trade to survive and the retail establishments cater primarily to non-residents. The economy of the town is tied to the use of the brick buildings. The ground levels are in use but the upper floors are vacant in many buildings. There is a classic battle between preservationists, who want too maintain the ensemble of historic buildings, and developers who for the last 8 years have been unable to build because of a moratorium on sewer hookups. This has kept population increases to a minimum in the town.

The town voted recently to authorize the extension of a sewer line to the community. A system has been developed, and is awaiting hookup, and the approval of a land use plan that would identify the future land use patterns and population growth. The population figure most acceptable to the community is about double the current 1,500 person population.

The study team talked to the owners of several buildings. They agreed that the preservation activity that had occurred over the last 20 years has been beneficial. More recently that activity has generated tourism and a new interest in rehabilitation of the existing buildings.

Enforcement of the Building Code. The city of Jacksonville enforced the building code with its own building official.

Recently, however, the official resigned because there was so little building permit activity occurring in town that it did not justify a permit official.

In the team's discussion with the official, he identified that only minor alterations and maintenance had been occurring to the URM building in town and permits were not issued on this type of cosmetic improvements. Because of the sewer moratorium and economic conditions no major rehabilitation had occurred for several years.

He also indicated that there was not a major effort to implement seismic provisions as part of the code enforcement, because there had been no history of earthquake activity. Inspections had not been made of existing buildings because no major rehabilitation activity had been occurring which would require permits. Potential structural hazards had not been identified or abated by the department.

Seismic Conditions in the Jacksonville Region. Jacksonville is located in the southern tip of the Cascade Range physiographic region, an area that is described as relatively quiet seismically. In 1877 a earthquake of estimated intensity of V11l was recorded in the region but subsequently few earthquakes have been felt in Jacksonville. In Jacksonville as in Oakland longtime residents did not recall ever experiencing an earthquake in the town.

IV. Use of Document

The research has revealed that the factors that affect the condition of unreinforced masonry buildings, and the application of seismic provisions, were diverse and interrelated. The history influencing the construction of the URM buildings, the economy of the individual towns, and the economic resources of the individual owners all played a role in the conditions that were observed in the case study buildings.

One important factor that was identified as the research progressed was the lack of knowledge of building owners, building officials and residents within the community concerning the potential hazards posed by their stock of masonry buildings. This lack of knowledge was apparent in the rehabilitations that had occurred and in only two buildings of the 35 buildings examined was any attention given to seismic provisions.

Increasing the Awareness of the Structural Conditions

It is hoped that the findings of this study will clarify the potential hazards posed by URM buildings in small towns and promote a better understanding of the structural characteristics of this type of building, since it is the predominant turn of the century structure found in towns throughout the Pacific Northwest. The findings of this report and the potential hazards identified by it, should provide an impetus for small towns to begin their own survey and mitigation program. Such programs should aim at reducing the most obvious and threatening hazards posed by that town's stock of URM structures.

The potential hazards of URM buildings that can most directly affect life safety are related to the separation of building appendages and the URM of the exterior of buildings. In past earthquakes(in cities like Seattle in 1949 and 1965) the lateral forces associated with earthquakes directly caused the failure of URM parapets, chimneys, and unanchored appendages. In the study towns with a maximum EPA of .20 the exterior URM elements of the building would be similarly affected even for EPA's considerably less than the maximum likely EPA. **Owners must be encouraged to examine the exterior elements of their buildings and especially if deterioration has reduced the strength of mortar and brick.**

Establishing a Mitigation Program

The costs for adopting a program for reducing potential hazards would be a concern for an owner who must incur the expense of retrofitting an existing structure and incorporating seismic provisions as part of the rehabilitation. The costs for securing a parapet, removing or tuckpointing loose brick, or tying URM appendages or walls may,however,be a small percentage of the total rehabilitation costs.

In one of the study towns the study team unstacked loose brick from an unused chimney which overhung the public right of way. The costs were zero. A potential hazard was reduced.

The recommendation on how buildings should be strengthened cannot be generally made without specific engineering examination and determination of the masonry's strength. However it has been shown repeatedly in past events that the anchorage of unreinforced masonry wall elements can reduce condsiderably the possiblity of their failure and and consequent injury to citizens.

The findings of this study can help to elucidate the

The findings of this study can help to elucidate the potential hazards that exist, serve as a vehicle for dialogue, and promote the adoption of a mitigation program in small towns. From this study it is apparent that a mitigation program in small towns should include the following:

--A Survey of URM buildings within the community for potential seismic hazards;

--Identification of the most serious buildings with the most serious hazards

--Establishment of a hazard mitigation strategy with structural engineering assistance to identify the mitigating measures that can be adopted

--Identification of the costs for specific reinforcement procedures

--Work with the owners to identify the the benefits that will result form reinforcement and the resources that they can apply to to the reduction of hazards found in their buildings

Periodic Check on the Condition of Buildings

The study team worked with many of the owners of the case study buildings to educate them on the necessity of preserving not only the facades of buildings but the structure themselves. In many of the buildings potential structural hazards had developed because of neglect and a lack of awareness of problems. The observation techniques employed by the research team can also be used by owners to periodically check their buildings for structural deterioration. The process for observing the condition of buildings can be quite simple when conceived in the form of movement from the basement to the roof coupled with the reporting of conditions like cracks,water damage, rot, roof leakage, Parapet condition, etc.

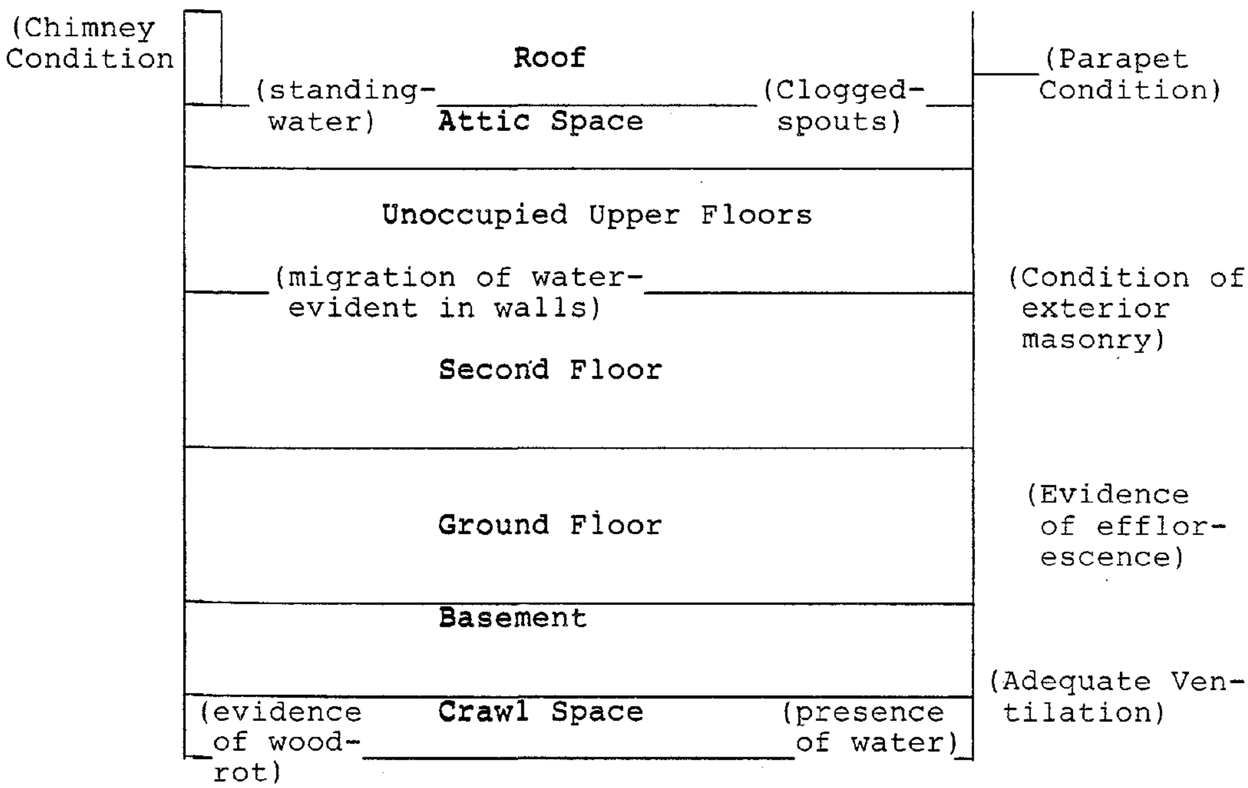


Chart of Areas of Buildings that Should be Observed Periodically by Owner to Check on Structural Conditions

The process of periodically observing the condition of the structural elements of a building provides a vehicle for identifying developing problems and therefore determining when maintenance and structural rehabilitation is desirable.

It is always best for an owner to contact a structural engineer or contractor, experienced in the rehabilitation of unreinforced masonry buildings,to determine when the problems so identified should be addressed and the most cost-effective maintenance and rehabilitation procedures.

H. Conclusion and Recommendations

Historic Preservation and the Structural Integrity of Masonry Buildings

Many local communities desire to maintain and preserve their share of this nation's older and historic buildings. Over the years this recognition of the desirability of preserving the physical memories of our past has grown and matured in many ways. In the late nineteenth and early twentieth centuries the great majority of the effort in the field of historic preservation was directed towards preserving the houses of important men and women. Since then efforts in historic preservation have evolved and grown into a desire to preserve a wide range of artifacts such as buildings, ships, trains, paths and cemeteries, associated with our past as a community.

Today historic preservation has come to be widely accepted and encouraged by the general public. The subject is taught in our schools and discussed in our museums and meeting halls. What once was a private philanthropic movement has since expanded into a largely public philanthropic effort. In 1966 the United States Congress passed the National Historic Preservation Act and codified and expanded the Federal Government's role in historic preservation. That law has been amended by subsequent legislation and now provides direct grant-in-aid monies to the states and tax reductions to individuals and companies who carry out historic preservation in approved fashion.

To guide the developer and architect of an historic rehabilitation project the Secretary of the Interior has promulgated a set of Standards for Rehabilitation. Those standards contain some nineteen specific recommendations and proscriptions covering items from roof and window treatment to signs and porches. Although there are three fairly innocuous recommemdations for treating structural systems, the booklet does contain one very precise proscription for the structural system of an historic building. Renovators are advised against "leaving known structural problems untreated that will cause continuing deterioration and will shorten life of the structure."

The Secretary of the Interior's Standards for Rehabilitation were written for administrators, architects and architectural historians. Their overriding concern is with maintaining the historical authenticity of a building. That approach is reflective of much of the more recent past and current thinking within the main currents of historic preservation in the United States. An historic building is supposed to say, (through its appearance) something specific about a period in time. If that appearance in uncharacteristically altered, then history is altered and defaced.

The Importance of Structure in Preservation

While it is quite understandable that the main focus of so much of historic preservation is on architectural integrity, there is a real need today to focus on preserving the structural integrity of historic buildings. Otherwise the building may not be around long enough to make any lasting statement.

The structural components of historic buildings and other older brick buildings, as is well known, at least superficially, are what hold the building together for us and future generations. The structural components of these buildings, to the trained and appreciative eye of an engineer are the most visible parts,but to the general public, architectural historian, and architect, they are invisible and secondary to the aesthetics of the structure.

Given that the structural system of an historic unreinforced masonry building is vitally important, and the corollary fact that it is also both the most inherently dangerous and the most common type of historic building in the Pacific Northwest, the obvious question to ask is, "What are the generally prevailing conditions for this type of structural system and how well would it respond to the infrequent but anticipated seismic event?"

The study team examined thirty-five buildings in three towns in Oregon and four towns in Washington. Those buildings were examined only for the most obvious signs of decay and risk, such as deteriorating mortar joints, unsecured parapets and cornices, evidences of wood-rot and inadequate and deteriorating foundations, and the conditions of floor to wall and roof to wall ties. Further the study was a survey and not an exhaustive and comprehensive hazardous building analysis. Nonetheless, enough abundant and convincing evidence was uncovered to make it clear that many of these historic and older unreinforced masonry buildings were very vulnerable to even relatively minor lateral forces. This danger includes not only the likelihood of a partial or total collapse with an event associated with a significant lateral force as a moderate earthquake, high wind or gas explosion, but also from the cumulative forces of natural erosion and decay. In these smaller towns and communities the study team found a significant number of buildings in which fallen bricks littered the sides of the buildings and where facade members, chimneys, cornices and parts of parapets had recently collapsed and fallen. Fortunately, there have been no injuries associated with these recent failures. However the photographs of this report provide convincing evidence of the present danger.

Lack of Knowledge Concerning the Structure of URM Buildings

No analysis of the existing problem is anywhere complete without asking how the current situation developed. In interviews conducted with all of of the thirty-five building owners, the building officials and the town officials, it was discovered that one overwhelming reason for the existing conditions was ignorance of both the inherent weakness of old unreinforced masonry buildings and possible maintenance and rehabilitation remedies.

The majority of both building and town officials were almost completely ignorant of what constitutes the structural strength or weakness of a building.

Many of the building and town officials in the small towns were also totally unaware of their and the building owners' liability in the event of a partial or total collapse of a building. In some of the towns, building permits have not been required even for a total rehabilitation project. As land use attorney R. Patrick McGreevy notes in the Appendix to this report, there is little question that both the building owners and the towns themselves are liable if there is a collapse or injury related to hazardous conditions that were not corrected.

One of the greatest worries that building owners and town officials have in dealing with unreinforced masonry buildings is a misconception of the financial cost of completing a sound structural retrofit or even removing or reducing the most dangerous elements of the building.

The team's survey of these towns and buildings indicated that there were some very serious structural problems with old and historic unreinforced masonry buildings. But as bad and pervasive as the problems appeared, there were also some encouraging signs. Increasingly, town officials and individual building owners are being made aware of the extent of the problem and the urgent need to deal with it.

Historically, or at least for the last dozen years, when URM historic buildings first began being renovated, building officials and structural engineers in general were thought of by building owners as the enemy. They were the ones who forced the owners of historic buildings to do more than was minimally necessary. For their part many structural engineers mistrusted preservationists for their lack of even the most basic understanding of the dangers inherent in URM buildings.

The economics of the rehabiltation, even with substantial tax benefits, frequently are very thin. It is understanable then why preservationists have always asked the engineers to proscribe less structural work keep the costs down. However that can validly be only a short term view which is inconsistent with any effort to preserve a historic building. Many such buildings are so structurally defficient that they are not going to be around long in the future unless their structural problems are adressed. Indeed, if those problems are not addressed, then some of the buildings examined with or without a earthquake could collapse in the very near future.

During the course of the research many dangerous buildings, were observed and though it was not an objective of this study it should also be noted that dangers related to fire were also observed. Some of these buildings were standing by the thinnest threads. The building official in Charleston, South Carolina, a city which was heavily damaged in the earthquake of 1886, spoke at a recent conference on seismic retrofit of existing buildings and stated that, in the last three years a "half dozen" unreinforced masonry buildings had collapsed in his city. Those collapses were attributed to vibrations caused by car traffic.

Clearly, the time has come for structural engineers and historic preservationists to begin to work more closely with one another and develop a mutual perspective on how to realistically preserve URM buildings. There is also a need to do more research into what constitues adequate and safe structural strengthening techniques and how buildings would survive after a shock.

In November 1984 a two-day conference on the initial findings of this study was held in Seattle, sponsored by the University of Washington's Department of Civil Engineering, the Northwest Institute of Historic Preservation, and the Washington State Office of Archaeology and Historic Preservation. The conference attracted a considerable attention and was attended by a wide spectrum of building owners, architects and engineers, town officials, historic preservationists, and building officials.

The recommendations of the conference are incorporated into the recommendations that follow. There have also been a couple of very immediate positive responses. The State Historic Preservation Officer for Washington has agreed to give his support for a series of seminars directed at building officials and building owners on how to remove the hazards associated with unreinforced masonry buildings. The town of Port Townsend is planning to conduct a hazardous building survey to identify and rectify its most dangerous buildings and the town of Bellingham has initiated a survey. The widely circulated magazine Small Town has asked the authors of this report to write an article issue for publication. The Washington State Legislature has also scheduled hearings on the subject during its 1985 session.

Recommendations

1) Every community should identify their hazardous buildings and adopt a program to abate those hazards

2) A strong effort should be made to work with the Structural Engineers Associations ,as well as the Building Officials, and Architects, of Idaho, Washington, and Oregon to establish a regional volunteer review board to assist local communities in dealing with hazardous Unreinforced Masonry buildings and and with the strengthening of those buildings.

It must be recognized that such hazardous buildings are both a cultural and economic resource and their loss would have a severe impact on local communities in the Pacific Northwest

3) Develop a educational pamphlet that can show building owners how to recognize hazardous conditions in URM buildings and what they can do to correct those hazards.

For the development of that pamphlet the various options for reducing potential hazards should be explored with building owners and contractors and details developed that are cost effective and satisfactory to both building owners and building officials.

4) Develop professional education seminars for engineers and architects specifically on latest developments in Unreinforced Masonry Building Analysis

5) Establish an alternative method to the Uniform Building Code that would serve as a guide to owners of URM buildings local officials, and building officials, on the possible techniques for reinforcing older and historic unreinforced masonry structures

Endnotes

Section

C. Seismic Risk in Washington and Oregon and the Potential Hazards of Unreinforced Masonry Buildings in the Study Towns

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III. Port Townsend

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[2] Personal Interview Port Townsend Building Official 5/22/84

[3] "Breaking the Code" The Daily News Port Angeles September 3, 1980

[4] Personal Interview State Fire Marshall 5/10/84

Section

III. McMinnville

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[3] Richard W. Couch, Robert Lowell, "Earthquakes and Seismic Energy Release in Oregon (State of Oregon Department of Geology and Mineral Industries) p.63

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III. Oakland

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